U.S. STEEL DUQUESNE WORKS
Along the Monongahela River
Duquesne
Allegheny County
Pennsylvania

HAER No. PA-115

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HISTORIC AMERICAN ENGINEERING RECORD

U.S. STEEL DUQUESNE WORKS

HAER NO. PA-115

LOCATION: The U.S. Steel Duquesne Works is located on the south side of the Monongahela River, about twelve miles upstream from Pittsburgh.

DATES OF CONSTRUCTION: 1886-1888, Duquesne Steel Company; 1888-1890, Allegheny Bessemer Steel Company; 1890-1901, Carnegie Steel Company; and 1901-1984, U.S. Steel Corporation.

PRESENT OWNER: USX Corporation, Regional Industrial Development Corporation

PRESENT USE: Vacant

SIGNIFICANCE: The construction of the Duquesne Steel Works marked an important event in the movement toward integrated steel producing ventures in the Monongahela Valley of western Pennsylvania. Constructed after the Edgar Thomson Works (1875), and the Homestead Works (1884), the Duquesne Works was the site of numerous technological innovations significant in the history of the American steel industry. The mill was the first to employ the "direct process" by which ingots were rolled directly from the soaking pits without being reheated. Under Carnegie Steel a new blast furnace plant was constructed with the industry's first fully mechanized material handling system, a innovation which came to be called the "Duquesne Revolution." For most of its history, Duquesne was a primary producer of semi-finished steel products. In the midst of a declining regional industrial system in the 1960s and 1970s, the mill was shut-down in 1984.

HISTORIAN: Joel Sabadasz, 1991

PROJECT INFORMATION:

The U.S. Steel Duquesne Works documentation project is part of a larger multi-year effort to document the historic steel mills of the Monongahela Valley by the Historic American Engineering Record (HAER), a division of the National Park Service, U.S. Department of the Interior, dedicated to documenting historically significant engineering and industrial works in the United States. The Monongahela Valley Recording project was cosponsored in 1989-90 by the Steel Industry Heritage Task Force, Jo H. Debolt, Chair and in subsequent years by the Steel Industry Heritage Corporation, August Carlino, Executive Director.

Documentation was prepared under the direction of G. Gray Fitzsimons, HAER Historian/Engineer. The recording team consisted of Christopher H. Marston, Supervising Architect, Matthew Severance and Joanna Winarska (ICOMOS), Architectural Technicians. Formal photography was done by Jet Lowe and Martin Stupich. Joel Sabadasz served as the project historian. Editors in HAER's Washington office were Dean Herrin, Michael Bennett and Lisa Pfueller Davidson.

Three additional steel mills were recorded as part of the 1989-90 documentation of historic steel mills in the Monongahela Valley:

U.S. Steel Edgar Thomson Works	HAER No. PA-384
U.S. Steel National Tube Works	HAER No. PA-380
U.S. Steel Homestead Works	HAER No. PA-200

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*A complete list of inventoried structures is located at the beginning of the appendix. Historical information appears at the end of each section of the inventory.

AN OVERVIEW HISTORY OF THE U.S. STEEL DUQUESNE WORKS

When the Duquesne Works first opened in 1889, its design and technological make-up both reflected and extended the revolutionary developments taking place in the American iron and steel industry. These developments made it possible for the industry to dramatically increase productive output while significantly reducing production costs. Over the succeeding years, until the works closed in 1984, Duquesne continued to lead the industry in these two vital areas. The works' layout and technology also provided the basis for linking Duquesne with other steelworks in the area, the development of labor-management relations within the works, the growth of the city of Duquesne, and the character of the city's environment. The history of the Duquesne Works can be divided into three distinct chronological periods: 1886-1917, a period of innovation in plant layout and technology; 1918-1945, a period of relatively minor technological developments, marked successful labor organization; and 1946-1988, a period during which facilities were modernized and equipped with new pollution control devices only to be shut-down when faced with the realities of a declining regional industrial base.

PART ONE: 1886-1917

The first period from 1886 to 1917 was characterized by innovation in layout design and technology. The nature of the physical layout and technology of the works -- actual or projected -- had an important influence on corporate development. The mill's technological character undercut the basis for the development of strong labor unions, while creating the need for a sizable workforce. Like other industrial communities along the Monongahela River, the city of Duquesne developed upon the hillside adjacent to the mill as the company acquired the available flat land along the river suitable for building. The community's proximity to the mill had an adverse effect on the environmental quality of residents' lives.

Technological Development, 1886-1917

The history of steelmaking at Duquesne began on June 4, 1886, when a group of Pittsburgh businessmen and manufacturers invested $350,000 to organize the Duquesne Steel Company for the purpose of producing Bessemer steel ingots and blooms. A large tract of farmland near the banks of the Monongahela River was purchased as the site of operations, and construction of the mill began shortly thereafter. It soon became apparent, however, that the project was undercapitalized, and construction was suspended amid serious disagreements among the partners. Construction did not begin again until March of 1888 when the enterprise was reorganized as the Allegheny Bessemer Steel Company with an increased capitalization of $700,000. The principle owners of the reorganized company, E. F. Clark of the Solar Iron Works and William G. and D. E. Park of the Black Diamond Steel Works, expanded upon the original conception of the enterprise (manufacture of ingots and blooms) to include the production of finished rails. Carl Amsler, a consulting engineer for Mackintosh, Hemphill & Company, supervised the building of the entire establishment.[1]

Under Amsler's direction, the new works was constructed to take full advantage of the revolutionary developments taking place in steel mill technology and layout design, thereby creating the basis for increased "throughput" within the facility.[2] The productive facilities of the new mill--a cupola house, a combined converting and blooming mill building containing two 7-ton Bessemer converters and 32" blooming mill, and a rail mill building--were fully integrated and synchronized with the existing Pittsburg, Virginia, and Charleston Railroad to facilitate the movement of materials in the works. In addition, the mill contained a blacksmith and machine shop as well as a boiler house for each building which housed equipment involved in the productive process.

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[1] "Furnace, Mill, and Factory," The Engineering and Mining Journal 41(June 26, 1886): 467; "Furnace, Mill, and Factory," The Engineering and Mining Journal 45(February 18, 1888): 130; "New Works of the Allegheny Bessemer Steel Company," American Manufacturer 44(January 25, 1889): 15; Stephen L. Goodale, Chronology of Iron and Steel (Cleveland: 1931), 212; James Howard Bridge, The Inside History of the Carnegie Steel Company (New York: 1903), 174-5; and Joseph Frazier Wall, Andrew Carnegie (Pittsburgh: 1989), 497.

[2] My use of the terms "steel mill technology," "layout design," and "throughput" are synonymous with Alfred D. Chandler's use of "technological change," "organizational change," and "throughput" in The Visible Hand: The Managerial Revolution in American Business (Cambridge: 1977), 240-1. "Technological change" or "steel mill technology" refers to innovations in materials, power sources, machinery, and other industrial artifacts. "Organizational change" or "layout design" refers to innovation in the ways such artifacts were arranged. This, in turn, affected the ways in which the movements and activities of workers and managers were coordinated and controlled. Throughput refers to the ways each of the above factors or any combination of them helped to increase the speed or volume of flow of materials through the processes of a single plant or works.

The mill not only employed state-of-the-art technology, but also introduced new, more powerful mill engines that made it possible to roll rails directly from the soaking pits without any intermediate reheating steps. The new engines eliminated an entire and expensive process in the rolling of rails, and came to be known as the "direct process." As a result, the mill was able to produce steel rails at a significantly lower price than those produced at competing mills, such as the nearby Edgar Thomson Works owned by Andrew Carnegie. Carnegie was quick to realize the adverse implications of this for his own business, and falsely discredited the new process by distributing a circular to all of the major railroads citing the unsafe quality of rails made by the direct rolling process. According the Carnegie's circular, rails made without any intermediate reheating steps were vulnerable to rupture because they lacked a homogeneous cellular structure.

Carnegie's attempt to discredit the rolling practices at the Allegheny Bessemer Steel Company severely limited the firm's ability to market rails. The lack of secure markets for its products, together with a summer-long strike which began in April of 1889, made the mill vulnerable to purchase overtures by Henry Clay Frick, the newly appointed president of Carnegie Brothers and Company. After several months of negotiation, the mill was sold to Carnegie in 1890 for $1,000,000 in bonds redeemable after five years. Immediately after the purchase, Carnegie adopted the direct rolling process at all of his mills. From that point on, nothing more was heard of the 'unsafe' features of direct rolling. The Duquesne Works, as it was now called, switched from the production of rails to the production of semi-finished products (blooms and billets) and became so profitable that the mill was paid for by the matured bonds without the Carnegie Company having to spend one cent of its own money for the purchase.[3] Carnegie's acquisition is considered by many historians as one of the greatest "steals" in American business history.

The most significant addition to the mill prior to the incorporation of U.S. Steel in 1901, was the construction of a new blast furnace plant. Built in 1895-1897, the plant formed part of an ongoing effort by Carnegie engineers to improve the productive capacity of the company's blast furnaces through the practice of "hard driving." This effort had begun in 1872 at the Carnegie-owned Lucy furnaces in Pittsburgh with the introduction

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[3] "Furnace, Mill, and Factory," <u>The Engineering and Mining Journal</u> (February 18, 1888): 130; "New Works of the Allegheny Bessemer Steel Company," 15; Bridge, <u>The Inside History</u>, 174-7; and Wall, <u>Andrew Carnegie</u>, 497-9.

of larger blast furnaces and more powerful blowing engines capable of blowing more cubic feet of air into the furnace per minute. During the late 1870s and early 1880s further advances were made at the Edgar Thomson Works when regenerative hot blast stoves were introduced for the purpose of creating hotter blasts to the furnace. The introduction of the new technology increased daily production from not more than fifty tons per day at a single furnace to an average of 330 tons per day in 1890. Yet the full potential of the new developments could not be realized because the delivery of raw materials to the furnace continued to be a manual operation.

In order to take full advantage of the potential offered by these innovations, Marvin A. Neeland, superintendent of engineering at the Duquesne Works, designed the industry's first automatic raw materials storage, handling, and delivery system for blast furnaces. The system, which employed the coordinated use of an ore storage yard, ore stocking bridges, a stocking trestle, a stockhouse, and bucket charging facilities to the furnace, quickly proved its worth. Each of the four Duquesne furnaces regularly produced more than 600 tons of iron per day. At the same time, labor costs were cut by 50 percent. As a result of this success, contemporary blast furnace experts soon labeled the innovation the "Duquesne Revolution," and it became the prototypical design for blast furnace plants in the industry.[4]

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[4]Bridge, The Inside History, 180-1; "The Duquesne Furnace Plant of the Carnegie Company, Limited," The Iron Age 59(March 25, 1897): 4-11; "The Duquesne Furnaces of the Carnegie Steel Co. Ltd.," The Iron Trade Review 30(March 25, 1897): 7-10; "The New Blast Furnaces at the Duquesne Works," The Engineering and Mining Journal 15(April 10, 1897): 355-8; Peter Temin, Iron and Steel in Nineteenth Century America: An Economic Inquiry (Cambridge: 1964), 157-163; James Gayley, "The Development of American Blast Furnaces with Special References to Large Yields," Transactions of the American Institute of Mining Engineers 19(1891): 936-7; E. C. Potter, "Review of American Blast Furnace Practice," Transactions of the American Institute of Mining Engineers 23(1893): 370-1; William P. Shinn, "The Genesis of the Edgar Thomson Blast Furnaces," Transactions of the American Institute of Mining Engineers 19(1891): 676-8; Wall, Andrew Carnegie, 324; William T. Hogan, Productivity in the Steel Industry: 1920 - 1946 (New York: 1950), 34-5; Axel Sahlin, "The Handling of Material at the Blast Furnace," Transactions of the American Institute of Mining Engineers 27(1897): 3, 11; John Birkinbine, "Twenty-Five Years of Engineering Progress in the Iron Industry," The Iron Trade Review 34(November 14, 1901): xxiii; Harold C. Livesay, Andrew Carnegie and the Rise of Big Business (Boston: 1975), 150; J. E. Johnson

The reputation of the Duquesne blast furnace plant as the most modern in the world was further enhanced by the introduction of the Uehling pig casting machine in 1898. Designed by Edward A. Uehling--who brought his invention to the Carnegie Steel Company after it was spurned by his former employer, the Sloss Furnace Company of Birmingham, Alabama--the machine replaced the arduous and time-consuming practice of casting pig iron into sand molds laid out on the floor of the cast house.[5]

Following the construction of the blast furnaces, Carnegie officials spent the next several years pondering the character and extent of future expansion and modernization efforts at Duquesne. At issue was the question of whether the mill should continue to produce semi-finished products exclusively or whether the product mix of the works should be expanded to include the production of finished products by building nail and wire mills on the site. The rationale for expanding Duquesne's product mix was rooted in the highly competitive nature of the steel industry in the late nineteenth century. As an exclusive producer of semi-finished steel, the mill's fortunes were dependent on its ability to market its output to firms producing finished products. Although the works had been quite profitable during the 1890s, by the turn of the century some of its most important customers were considering constructing their own facilities to produce semi-finished products. Companies already engaged in such production included the American Steel and Wire Company, the American Steel Hoop Company, and the National Tube Company. Facing the loss of stable markets, the company's board of directors, led by Andrew Carnegie and Charles Schwab, pushed for the construction of nail and wire mills at Duquesne as well as the construction of a new tube works along the banks of Lake Erie in Conneaut, Ohio.[6] In a letter to Schwab, Carnegie justified his position in terms of the Social Darwinian principles popularized by Herbert Spencer:

Jr., Blast Furnace Construction in America (New York: 1917), 15-6; Richard Peters Jr., Two Centuries of Iron Smelting in Pennsylvania (Philadelphia: 1921), 60-1; Harold E. McGannon, ed., The Making, Shaping, and Treating of Steel, Eighth Edition, (Pittsburgh: 1964), 9.

[5]E. A. Uehling, "Advantages of Sandless Pig Iron," The Iron Trade Review 31(March 3, 1898): 14-16; Gary B. Kulik, "Sloss-Sheffield Steel and Iron Company Furnaces, 1976" HAER No. AL-3, p. 5, Historic American Engineering Record, National Park Service.

[6]Wall, Andrew Carnegie, 767-74; Robert Hessen, Steel Titan: The Life of Charles M. Schwab (New York: 1975), 111-13.

> ...a struggle is inevitable, and it is a question of the survival of the fittest. For many years we have seen that the manufacturer must sell finished articles. One who attempts to stop halfway will be crowded out...[7]

The threat of the Carnegie Steel Company manufacturing finished steel products prompted the nation's leading financier, J. Pierpont Morgan, who also controlled the National Tube Company, to begin negotiations with Carnegie and the nation's other leading steel companies. As a result, in 1901 the Carnegie Steel Company merged with the American Steel and Wire Company, American Steel Hoop Company, and the National Tube Company, among others, to form the United States Steel Corporation. Because the new corporation included the primary customers of semi-finished products produced at Duquesne, plans to construct the nail and wire mills at the works were abandoned.[8]

The ironmaking, steelmaking, and steelshaping facilities at Duquesne were completely modernized in the first sixteen years following the creation of the United States Steel Company. During this period, Duquesne's ironmaking plant became a focal point in an industry-wide effort to improve "hard driving" methods through the production of clean blast furnace gas. Production was restricted by fine particles of flue dust entrained in the blast furnace gas that passed through the regenerative hot blast stoves. As the gas burned inside the stoves, the particles became lodged inside the stoves' checkerwork, thus constricting and eventually clogging up the openings which allowed for the passage of gas and cold blast air. As a result, each stove had to be taken off line for a period of five or six days every two months for a complete cleaning. Compounding the problem was the decision of plant managers to use gas-powered blowing engines in conjunction with the installation of two additional blast furnaces in 1909. In order for the engines to operate efficiently on blast furnace gas, the gas had to be almost completely free of entrained particulate.

Ambrose N. Diehl, superintendent of the blast furnace plant, overcame these difficulties by designing a wet gas cleaning system on site in 1909. Originally conducted on the basis of a four year experiment, the system consisted of a series of nine pressurized spray towers and a set of four Theisen rotary washers to which the gas was led in succession after it had left its respective blast furnace and dustcatcher. During the entire

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[7]Wall, Andrew Carnegie, 773.

[8]Wall, Andrew Carnegie, 774-93; and Robert Hessen, Steel Titan: The Life of Charles M. Schwab (New York: 1975), 113-18.

period of the experiment, not one stove was taken off line for cleaning. The successful application of wet blast furnace gas cleaning made it possible to design stoves with significantly smaller checkerwork openings, thereby substantially increasing the total heating surface of each stove. This resulted in the production of higher hot blast temperatures, which increased the output of each furnace. Results such as these, as well as the information his experiment yielded, made Diehl one of the foremost authorities on blast furnace gas cleaning in the industry. The system he devised became a standard method of cleaning blast furnace gas.[9]

The modernization of the steelmaking facilities at the Duquesne Works began in 1901 with the construction of a basic open hearth plant (Open Hearth Number One), consisting of twelve 50-ton stationary open hearth furnaces. Open hearth technology was first developed for commercial use at the nearby Homestead Works in 1888, and had two important advantages over the older Bessemer steelmaking process. First, open hearth furnaces were able to eliminate phosphorus and sulphur from molten iron, something that could not be done with Bessemer converters. This opened up vast quantities of American iron ore deposits high in phosphorus content for use in steelmaking. Second, the use of open hearth technology allowed for the production of many more grades of steel than could be produced in Bessemer converters. This was especially significant at Duquesne which became an important producer of specialized steel bars for the eastern market throughout most of the twentieth century. In 1908, as a consequence of these advantages, Bessemer steelmaking was completely abandoned when a second basic open hearth plant (Open Hearth Number Two) was constructed. Finally, a 20-ton capacity Heroult electric furnace was built at one end of the furnace building at Open Hearth Number Two in 1917 for the purpose of further refining certain grades of molten open hearth steel.[10]

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[9]A. N. Diehl, "The Blast Furnace Regenerative Stove," The Iron Age 89(March 7, 1912): 580; "Operation of Blast Furnace Gas Engines," The Iron Age 88(July 6, 1911): 36-8; A. N. Diehl, "Data Pertaining to Gas Cleaning at the Duquesne Blast Furnaces," Transactions of the American Institute of Mining Engineers 50(1915): 3-46; J. M. Camp and C. B. Francis, eds., The Making, Fourth Edition, 175-9; A. N. Diehl, "How to Clean Blast Furnace Gas," The Iron Trade Review 54(March 26, 1914): 590-3; A. N. Diehl, "Keeping Your Furnace Gas Clean," The Iron Trade Review 54(March 12, 1914): 516-8; and Johnson, Blast Furnace Construction, 298, 306-7, 322-7.

[10]"The Open Hearth Plant and 40-Inch Blooming Mill of the Carnegie Steel Co., at Duquesne, Pa.," The Iron Trade Review

Complementing open hearth construction was the installation of a full line of steam powered primary rolling and bar rolling facilities. The installation of these facilities--which enabled the works to produce bars in the shape of rounds, flats, and squares--began with the construction of a 40" blooming mill, a 14" continuous billet mill, and two bar mills (10" and 13") as part of the modernization effort that included the construction of Open Hearth Number One.

A particularly significant feature of the new bar mills was their ability to roll bars at lengths longer than the customary limit of 50'. Until that time, the length of bars was limited because of the uneven temperature of each billet which was being rolled. Billets had been traditionally heated in batch furnaces prior to rolling. When the billet reached rolling temperature, it was removed from the furnace and run through the various roll stands making up the bar mill. As the billet was being rolled, however, the back end of the billet, which entered the rolls last, cooled below the proper rolling temperature. This made it impossible to reduce the entire billet to a uniform cross-sectional diameter. As a result, a certain percentage of each bar had to be scrapped at the end of the rolling process. In order to keep the proportion of scrap to a minimum, billet lengths were limited. The bar mills at Duquesne, however, employed a continuous furnace whereby the back end of each billet remained in the furnace until its front end had made its many passes through the rolls, thus guaranteeing that the back end of the billet remained at the proper rolling temperature when its turn came to pass through the rolls. This made it possible to use longer billets than before and thus allowed for an increase in the length of bars.[11]

36(January 1, 1903): 84-5; "The Duquesne Works of the Carnegie Steel Company: The Open Hearth Plant and the Blooming and 14-Inch Morgan Continuous Mills," The Iron Age 71(January 1, 1903): 12-14; Camp and Francis, eds., The Making, 200, 386-93; United States Steel Corporation, The Making, Shaping, and Treating of Steel, Sixth Edition, (Pittsburgh: 1951), 401; Duquesne Works, Steelmaking Division, "Duquesne Works-Steel Production Conference, 1951," p. 41, Collection of USX Corporation; "Open Hearth Installation at Duquesne Completed-Bessemer Converters Replaced," The Iron Trade Review 45(August 5, 1909): 242; "Corporation's Electric Steel Output," The Iron Age 97(June 1, 1916): 1329.

[11]"The Open Hearth Plant and 40-Inch Blooming Mill of the Carnegie Steel Co., at Duquesne, Pa.," 85-9; "The Duquesne Works of the Carnegie Steel Company: The Open Hearth Plant and the Blooming and 14-Inch Morgan Continuous Mills," 15-20; "The Duquesne Merchant Bar Mills of the Carnegie Steel Company," The Iron Trade Review

Duquesne's bar rolling capacity was further expanded over the next several years with the addition of five steam powered mills, beginning with the construction of an 8" guide mill in 1905. In that same year, a 10" guide mill was relocated from the Girard Works in Monessen, Pennsylvania, to the Duquesne site. This was followed by the construction of a 22" bar mill in 1906, a 10" semi-continuous Belgian or looping mill complete with automatic repeaters in 1913, and a 12" cross-country mill in 1917.[12]

By the time America entered World War I, the Duquesne Steel Works stood as one of the most modern steelmaking facilities in the nation. Its product base was expanded to include a variety of semi-finished goods, and its iron and steelmaking capacity was greatly increased. While these technological changes enhanced the mills position both in the region and in the nation, they also realigned the relationship between labor and processes. Since it was sold to Carnegie Steel, Duquesne has been a non-union mill, like most of the steel mills in the Pittsburgh District. Despite a bitter strike in 1919, labor was unable to mobilize into a full-scale union until the Wagner Act, initiated by President Franklin D. Roosevelt in the 1930s.

Technology and Labor, 1886-1917

When the Allegheny Bessemer Steel Company opened for business in 1889, the Amalgamated Association of Iron and Steel Workers union was at the peak of its strength. Its power, however, was rooted in the older forms of technology associated with the production of wrought iron rather than in the technology of the burgeoning steel industry. The technology associated with the wrought iron industry was organized around a system of batch production. Within this system, pig iron, in small batches of about 550 pounds each, was manually refined in puddling furnaces and later rolled into wrought iron shapes within rolling facilities that required a high degree of hand work in the manipulation and actual rolling of the material. The system was highly dependent upon the manual dexterity and knowledge of skilled puddlers and rollers who determined when to engage in the

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36(January 8, 1903): 36-42; "The Duquesne Works of the Carnegie Steel Company - II: The Merchant Bar Mill," The Iron Age 71(January 8, 1903): 1-4.

[12]Carnegie Steel Company. "Duquesne Works: Plant Description Book" (Duquesne, 1925): 99, 101, 104-7, 114-6, and 120; "Carnegie Extensions at Duquesne." The Iron Age, Vol.78, (October 25, 1906): 1104; "Newest Type of Merchant Bar Mill." The Iron Trade Review, Vol. 58, No. 1, (January 6, 1916): 62-4; J. M. Camp and C. B. Francis. The Making, Fourth Edition: 602.

various stages inherent in the refining and rolling processes. They calculated the chemical and metallurgical composition of the material through visual inspection, while directing the work of one or more helpers. Variations in the chemical and metallurgical composition of specific batches of both pig and wrought iron meant that the puddling and rolling processes rarely followed the same pattern from batch to batch. This, in turn, further enhanced the indispensability of the skilled craftsman, for only highly trained and experienced workers could cope with the variables inherent in the production process.[13]

The central, self-directing role that iron puddlers and rollers played in the production of wrought iron products conferred much power upon them with respect to their employers. Their superior knowledge of the production process gave them the opportunity to create strong unions for themselves and their crew members from which they could exercise a significant amount of control over the pace and allocation of work as well as the benefits derived from their labor. For example, in addition to negotiating a tonnage rate for the work to be done, union puddlers also unilaterally fixed a stint of five pig iron charges per furnace a day by 1870. Union rolling crews, after negotiating a single tonnage rate for work to be done with the company, collectively decided among themselves what portion of the rate should go to each crew member. They also decided how the work should be allocated between the different crews, how much rolling should be done each day, and how new members should be hired and allowed to progress through the ranks of the crew.[14]

Unlike the wrought-iron industry, the technological basis of the steel industry was modelled on a system of continuous flow production. The system, which was grounded upon four factors, had significant consequences with regard to the traditional labor

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[13]David Montgomery, <u>The Fall of the House of Labor: The Workplace, the State, and American Labor Activism, 1865 - 1925</u> (New York: 1987), 35; John A. Fitch, <u>The Steel Workers</u> (Pittsburgh: 1989), 87; For a more indepth discussion of the relationship between skilled craftsman and the process involved in the production of wrought iron products see Michael Nuwer, "From Batch to Flow: Production Technology and Workforce Skills in the Steel Industry, 1880-1920," <u>Technology and Culture</u> 29(October 1988): 812-5.

[14]Montgomery, <u>The Fall of the House of Labor</u>, 16; Montgomery, <u>Workers Control in America: Studies in the History of Work, Technology, and Labor Struggles</u> (New York: 1979), 11-2; David Brody, <u>Steelworkers in America: The Nonunion Era</u> (New York: 1960), 52.

structure within the metals industry. First, the metalmaking equipment employed in steel was of a much larger scale than that used in the production of wrought-iron. The typical puddling furnace, for example, was limited to a charge of 550 pounds. This meant that firms which wanted to produce large quantities of wrought iron were required to employ numerous furnaces, each with an attendant skilled puddler. Bessemer converters, on the other hand, could handle charges from seven to fifteen tons. A typical two converter plant, like the one at Duquesne, was supervised by only one man called the blower. Second, the equipment used in the rolling of steel shapes became increasingly automatic with the development of steam and electric power sources. The installation of such equipment as continuous furnaces, automatic reversing mills with their attendant power driven entry, exit, and runoff tables, and repeaters eliminated the need for many of the skilled heaters, roughers, catchers, and hookers that traditionally made up a wrought-iron rolling crew. Third, the adaptation of steam and electric power sources to material handling equipment such as electric overhead traveling cranes and rail transportation made it possible to achieve optimum output from the new technology. As a result, "throughput" within a steelworks was greatly increased by integrating its productive and material handling equipment. Finally, the adaptation of the metallurgical and chemical sciences to the steelmaking process eliminated the heretofore valuable visual skills of puddlers and rollers. This was accomplished by on-site laboratory testing procedures that could determine the chemical and metallurgical composition of the steel at regular intervals throughout the productive process, by developing a line of chemical additives that could be added to freshly tapped ladles of molten steel. The combination of the two--laboratory testing and ladle additions--allowed for the standardization of the production process for predetermined grades of steel.[15]

Despite the fact that the technology inherent in steel production increasingly made the skills which formed the basis of the union's strength redundant, the Amalgamated Association consciously sought to adapt its traditional structure to the industry. In doing so, it showed an awareness of the consequences new equipment had on membership rolls by agreeing not to resist technological improvements, even to the point of assisting in their development. In return, the association asked for a pledge from the company to recognize the principle of

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[15]Nuwer, "From Batch to Flow," 815-33; Brody, Steelworkers in America, 27-31; Neil F. Dowlan, "Mass Production Systems and Material Handling in the Pittsburgh Steel Industry," manuscript in HAER office, p. 1-79, Historic American Engineering Record, National Park Service, 1989.

unionism among the skilled workforce remaining after the improvements had been made. Initially, the results of the Amalgamated Association's policy of accommodation were mixed. By the late 1890s, however, the policy proved to be a complete failure.[16] Nowhere was this more evident than in the steel mills of the lower Monongahela River Valley.

The Edgar Thomson Works in Braddock, the Homestead Works, and the Allegheny Bessemer Steel Company in Duquesne were the only facilities in the valley devoted exclusively to steel production at the time. During the 1880s, local lodges affiliated with the Amalgamated Association attempted to gain a foothold in each of them. At the Edgar Thomson Works, the union men enjoyed only fleeting success, establishing two local lodges in 1882. In 1885, however, technological improvements at the works resulted in the displacement of fifty-seven of the sixty-nine men on the heating furnaces and fifty-one of the sixty-three men on the rail mill train. This so depleted the membership of the local lodges that they were forced to dissolve. The efforts of the Amalgamated Association at the Homestead Works were more successful, as two local lodges won a bitter strike for union recognition in the spring of 1882. Over the next few years the number of lodges at the works grew to four in 1887 and then to six in 1889. In the latter year, the local lodges maintained union recognition by winning another bitter strike.[17]

Given the mixed results of the Amalgamated Association's efforts to gain a foothold in the Edgar Thomson and Homestead steel mills, its attempt to organize the works of the newly established Allegheny Bessemer Steel Company in 1889 can be viewed as pivotal with respect to the subsequent history of steel unionism in the Monongahela Valley. A successful attempt there might lead to increased momentum in the Amalgamated Association's efforts. Failure, on the other hand, would result in the virtual isolation of the Homestead Works as a unionized entity.

The principle owners of the new enterprise were determined to run the mill on an open shop basis. Shortly after the works opened for business in April 1889, signs were posted all over the yards and shops announcing that no union men were allowed within the mill. In addition, the company offered the lowest wage rates

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[16]Wall, Andrew Carnegie, 553; Brody, Steelworkers in America, 50-60; and Montgomery, The Fall of the House of Labor, 35-44.

[17]Fitch, The Steel Workers, 111; Brody, Steelworkers in America, 51; Wall, Andrew Carnegie, 539, 487, 528-30; Paul Lewin Krause, "The Road to Homestead," (Phd. diss., Duke University, 1987), 388-543.

in the area, even below those of other non-union mills. Union men, upon learning that they had been locked out of the works, set up picket lines in an attempt to dissuade non-union workers, many of whom were recently arrived immigrants from Eastern Europe, from entering the mill. The company responded by employing the services of the Allegheny County Sheriff's department to protect workers who crossed the picket line. The lockout dragged on for most of the summer, finally ending in early August. During that time, the locked out men received support in the form of money and foodstuffs from the Homestead lodges and from the union lodges representing the organized wrought-iron mills in the area. They also gained a moral victory in May when the company, which was already beleaguered by the false rumors being spread by Carnegie regarding the shortcomings of direct rolling, had to accept the return of seven carloads of rails from a railway customer because of shoddy work. Nevertheless, the lockout ended in a complete victory for the company. As evidenced by the events at Homestead in 1892, the Amalgamated Association's experience at the Edgar Thomson Works and Duquesne were portents for the future. After 1892, the steel mills in the Monongahela Valley would remain unorganized until the 1930s.[18]

Plant and Community, 1886-1917

The Duquesne Works was constructed on farmland in an area known as Riverside, close to a settlement called "Dutchtown" in Mifflin Township. At the time it was built, the area was primarily agricultural and had no more than a few dozen local inhabitants of Scots Irish and German lineage. Soon after the works was built, the local population grew rapidly as men came looking for work. By 1891, the newly incorporated Borough of Duquesne had a population of 2,000. This grew to 9,036 in 1900 and finally to nearly 19,000 when the 913 acres comprising the borough was incorporated as a third-class city in 1917. The ethnic makeup of the population reflected contemporary trends for industrializing communities. By 1900 three out of every eight residents were foreign born, most were from Ireland and Eastern Europe. The remainder of the population was mostly native born white. Only 195 African-Americans lived in the borough until World War I when the black population grew as migrants left the

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[18] The National Labor Tribune, April 20, 27, May 4, 18, 25, June 8, 15, 29, and August 10, 1889; Bridge, Inside History, 177-8; James Dougherty, "Markets, Profits, and Labor Management Relations: The Mon Valley Steel Mills, 1880s-1980s," manuscript in HAER office, p. 18-20, Historic American Engineering Record, National Park Service, 1989.

south to work in northern industrial districts.[19]

As the opportunity for work in the mill attracted ever increasing numbers of people to Duquesne, its infrastructure became increasingly complex. When the mill was first constructed, the area's major thoroughfare, Grant Avenue, was no more than a dirt road bordered by a wooden boardwalk. Two other roads in the area, according to a local historian, were impassable mud lanes. By the mid 1890s, however, borough officials, many of whom were also supervisors within the mill, authorized a public improvement program that resulted in the construction of 44.8 miles of streets within the city, a modern water works, and a rail transportation system that connected the town to Pittsburgh and McKeesport. The improvements to Duquesne's infrastructure were far from uniform. Of the 44.8 miles of streets in the town, for example, only twelve miles were paved. Most of the unpaved roads, moreover, were located in working-class neighborhoods.[20]

Beyond creating the basis for the growth of an industrial city, the activities of the Duquesne Works resulted in negative consequences for the environmental character of the community. One factor influencing the city's environment stemmed from the physical location of the works. Because the mill needed large quantities of water both for the cooling of equipment and the cleaning of waste products generated by the steelmaking process, the works was laid out on a narrow strip of land bordering the Monongahela River. The development not only blocked a view of the river for generations of local residents, but also rendered it unusable for recreational purposes because the effluent from the cooling and cleaning processes continuously discharged back into the river was laden with toxins. The nature of the mill's equipment also had an adverse effect on the community's air quality. Noxious fumes emanating from the work's smokestacks particularly affected air quality in working-class neighborhoods which were, for the most part, located closest to the mill. Dirt generated by the smoke covered the landscape and forced working-class housewives to interminable hours of house cleaning each day. Although mill management attempted to ameliorate living conditions in the city through social-welfare programs which

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[19]Robert Evans, "Thriving City Created on Site of Grain Fields," <u>The Daily News, McKeesport, Pa.</u>, June 30, 1934; <u>1900 U. S. Population Census</u>, Vol. 1: 675.

[20]Robert Evans, "Thriving City,"; As was common for industrial communities in western Pennsylvania, there was a uneven distribution of basic services and urban infrastructure between working class and middle class neighborhoods.

financed the construction of playgrounds and swimming pools in working-class neighborhoods, and provided instruction to working-class mothers on the middle-class principles of good housekeeping, the environmental character of the city would not improve until the development of new technology after World War II in response to more stringent environmental regulations.[21]

PART TWO: 1918-1945

Even though the mill gained an important addition with the construction of an electric furnace plant and heat treating facility in 1943, its technological development was relatively stagnant in the years between World War I and II. Efforts to organize steel labor increased during this period, leading to a national strike in 1919, and finally the establishment of the United Steel Workers of America in the 1930s. An important element of this movement toward unionism was the workers' desire to gain a more equitable share of the benefits derived from increasing productivity. The eventual success of organized labor, along with the construction of the electric furnace and heat treating facilities, significantly altered the city's physical, social, and political composition.

Technological Development, 1918-1955

Between 1918 and 1924, the blast furnace plant at Duquesne underwent a major reconstruction. Prompted, in part, by the need to upgrade the plant's raw materials storage, handling, and delivery facilities, the reconstruction reflected the quick pace of technological change in the steel industry during the late nineteenth and early twentieth centuries. Although Marvin Neeland's design remained the prototype from which blast furnace plant raw materials facilities were constructed, much of the equipment making up that design became antiquated in the twenty years since the plant was built. As a result, company officials authorized an almost complete modernization of the plant's auxiliary equipment. The original ore bridges were replaced, and the stockhouse was modernized with the construction of hoist bucket pits at each furnace, the installation of electrically powered scale cars for the delivery of raw materials to the bucket, and the construction of a coke dust removal plant. Finally, a new hoist house was built, complete with the

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[21] S. J. Kleinberg, The Shadow of the Mills: Working-Class Families in Pittsburgh, 1870-1907 (Pittsburgh: University of Pittsburgh Press, 1989), 65-99; Beth Shervey, "Steelmaking and the Growth of Monongahela Valley Mill Towns," manuscript in HAER office, p.9, Historic American Engineering Record, National Park Service, 1989; "Features of Welfare Work at Duquesne, Pa.," The Iron Age 97(January 20, 1916): 193-96.

installation of modern electrically powered hoisting equipment, at each furnace.[22]

The construction of a central boiler house in 1929 gave plant officials more flexibility and control over the generation of steam power throughout the works. Before its construction, steam was generated by a decentralized system of boilers located at each of the mill's component plants (i.e. blast furnace plant, open hearth plant, and rolling mills). Decentralization created the potential for the disruption of material flow through the works if the boilers at a particular site broke down. The design of the central boiler house overcame this problem because additional back-up boilers were provided for such emergencies. Another important feature of the new facility was the character of its boilers. Because the new facility contained six gas-fired and six coal-fired boilers, plant managers were better able to contain operating costs by having the option of using the cheapest fuel available at any particular time.[23]

Finally, the construction of a modern electric furnace plant and heat treating facility in 1943 significantly increased the versatility of Duquesne's steelmaking operations. It also provided an important link to neighboring U. S. Steel facilities such as the forging plant at the Homestead Works. Built at a cost of $10,000,000 by the Defense Plant Corporation (D.P.C.) in order to aid in the war effort, the electric furnace plant provided the Homestead Works with high quality alloy steel ingots. The ingots were subsequently forged into armor plate for the U.S. Navy Department at Homestead's newly constructed, D.P.C. financed, heavy forging plant. After the war ended the new facilities allowed Duquesne to enter the burgeoning market for semi-finished alloy steel products.[24]

Technology and Labor, 1918-1945

Organized labor made several attempts to gain recognition

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[22]Carnegie Steel Company, "Duquesne Works: Plant Description Book," 15-6, 25-8; The Duquesne Times, April 11, and 18, 1924; The Daily News, McKeesport, Pa., April 18, 1924; and "New Capacity in Iron and Steel Works," The Iron Age 113(January 3, 1924): 110.

[23]J. Patrick Ely, former General Superintendent of the National-Duquesne Works, interview with author, July 11, 1989.

[24]"Alloy Steel Plant"- Duquesne, Penna.," Defense Plant Corporation Brochure - Plancor 186D (Washington: 1943), 1-8; T. J. Ess, "War Time Expansion of Carnegie-Illinois Steel Corporation in the Pittsburgh District," Iron and Steel Engineer 24(September 1947): C-I 13 - C-I - 32.

within the Duquesne Works between 1918 and 1945. Each was part of a larger effort to organize the steel industry nationwide and each, recognizing the realities of the job structures created by the technology of steel production, abandoned the craft exclusiveness of earlier union drives for a strategy based on some variant of industrial unionism. As with previous efforts, trade unionists sought to gain some measure of control over the technology in terms of the time spent operating it and the benefits derived from its output. Unlike previous efforts, however, their success or failure depended less on the increasingly outmoded occupational categories that formed the basis of the Amalgamated Association's activity than on social and political factors that bore little direct relationship to technological development.

The first attempt at forming a union was made by the American Federation of Labor after America entered World War I. It culminated in the great steel strike of 1919. The impetus for organizing resulted from the favorable political climate created by an agreement between the A. F. of L. and the administration of President Woodrow Wilson. In return for the Federation's support of the national war effort, the administration, through the auspices of its National War Labor Board (NWLB), asserted the right of workers to organize into trade unions without any interference by employers. Shortly thereafter, in August of 1918, the Federation created the National Committee for Organizing the Iron and Steel Workers. The National Committee consisted of representatives from twenty-four member unions of the A. F. of L., each claiming some jurisdiction over workers in the steel industry. In order to prevent a fragmented approach to its organizational efforts, the National Committee agreed to conduct a unified effort and to centralize the newly created local chapters of the member unions at each steel center into informal central bodies known as Iron and Steel Workers Councils. The largest number of steelworkers -- i.e. those having no skill -- were given over to the Amalgamated Association which claimed about one-half of the total number of steelworkers.

Despite declarations of unity and pledges of financial support by the member unions, the effort was hampered by jurisdictional disputes and meager operating expenses. Nevertheless, by skillfully appealing to immigrant workers around the concept of the eight-hour workday and by associating national war aims (making the world safe for democracy), with trade union goals (the extension of industrial democracy in America), the National Committee was able to enroll 100,000 steelworkers nationwide by late in the spring of 1919. This number reached an estimated 300,000 by September 22nd when the NWLB was dissolved and the recalcitrance of employers led the National Committee to call a nationwide strike for union recognition.

A disproportionately low number of new recruits came from the U.S. Steel Corporation mills in Monongahela Valley, almost none from the Duquesne Works. The National Committee's inability to effectively organize steelworkers in the Monongahela Valley stemmed from two sources. First, a high level of ethnic discord between the highly skilled native born white workforce and their mostly unskilled foreign born counterparts fragmented the effort. Only two percent of the native born workforce participated in the movement since most did not want to be associated with a strike viewed as the work of unskilled immigrant labor. Secondly, an interlocking relationship between local political leaders and steel company managers severely impaired the ability of union organizers to conduct operations in the surrounding mill towns. During the first months of the organizational drive in the winter of 1918-19, local leaders were able to prevent the union men from holding meetings by denying their requests for access to local buildings. Although the National Committee was able to overcome this obstacle by holding outdoor rallies in the spring and summer, their efforts led to a repressive backlash against strikers in the valley. The Pennsylvania Constabulary, at the request of the Allegheny County Sheriff whose brother was the general manager of U. S. Steel's Farrell subsidiary of the American Sheet and Tin Company, provided mounted police to patrol the mill towns throughout the duration of the strike. They clubbed men and women off the streets and dragged strikers from their homes, jailing them on flimsy charges. Although the strike was never completely broken in the region, U. S. Steel was able to operate its Monongahela Valley mills at sixty percent capacity throughout the dispute. Because the valley was the major center of the Corporation's nationwide operations, its ability to keep the mills open doomed the strike, which was called off in January of 1920.

Nowhere, finally, was the interlocking relationship between local political leaders and steel company managers more detrimental to trade union activities than in Duquesne. Duquesne's mayor, James Crawford, was closely connected to management circles through his brother, Edwin, who owned the nearby McKeesport Tin Plate Company. During the organizing phase of the National Committee's effort, Crawford prevented union men from establishing themselves in the city by invoking a local ordinance requiring organizations to obtain a permit from the mayor's office before holding public meetings. No permits were ever granted to National Committee officials. Other ordinances were also passed to make it illegal for able men at least eighteen years of age to be unemployed. Later, during the first few days of the strike, the mayor, who was also president of the First National Bank of Duquesne, called together the city's property owners and merchants and instructed them to accept only cash payments for food and rent from all employees of the steelworks. Then he organized a Citizens Committee of over one hundred people that visited the home of every known striker in the city with the objective of coercing them into returning to work. Through these efforts, the Duquesne Works remained virtually free of strike activity throughout the entire affair.[25]

The defeat of the National Committee marked the end of all substantial efforts to organize steelworkers in the region until 1933 when the federal administration of Franklin Delano Roosevelt, in an attempt to raise the national economy from the depths of the Great Depression, sought the support of the A. F. of L. for its proposed National Industrial Recovery Act (NIRA). In return for its support, the Federation managed to gain the insertion of a clause in the act, Section 7a, stipulating that all employees had the right to organize and bargain collectively through representatives of their own choosing. Almost immediately after the NIRA was enacted, however, the U. S. Steel Corporation attempted to neutralize the potential for independent union activity in its steel mills while adhering to the guidelines of Section 7a by sponsoring an Employee Representation Plan (ERP) at each of its productive facilities.[26]

Each ERP was set up as a self-contained unit, authorized to deal only with problems affecting the particular steel mill in which it was organized. All corporation-wide decisions remained within the purview of corporate officials in Pittsburgh. Within each plan, employee representatives were democratically elected from the individual departments within the mill. Once elected, the representative had the right to present the 'requests' of his departmental constituents to management representatives in what amounted to a four step grievance procedure beginning with the grievant's foreman and running through the departmental superintendent, management's designated representative to the ERP, and finally the General Superintendent. In addition, employee and management representatives, who were made up of the

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[25]David Brody provides a complete history of the national effort to organize the steel industry in 1919 in Steelworkers in America, 199-262; Brody also summarizes these events in "The American Worker in the Progressive Era" in Workers in Industrial America: Essays on the 20th Century Struggle (New York, 1980): 42-3; A detailed history of the local events surrounding the 1919 strike can be found in Frank Serene, "Immigrant Steelworkers in the Monongahela Valley: Their Communities and the Development of a Labor Class-Consciousness, 1880-1920," (Phd dissertation, University of Pittsburgh, 1979), 193-247.

[26]Irving Bernstein, Turbulent Years: A History of the American Worker, 1933-1941 (Boston: 1971), 27-31, 455.

various departmental superintendents, each formed parallel committees around such matters as requests, education, and safety. These committees met both separately and jointly. Finally all employee and management representatives met at regular intervals to discuss general problems.[27]

Despite two major challenges, the ERP remained the model for labor relations at the Monongahela Valley mills of U. S. Steel over the next several years. The first challenge occurred in the fall of 1933 when a coal miners' strike against U. S. Steel for recognition of their United Mine Workers of America union locals spread to the Clairton Works. Because the Clairton Works supplied coke to the Corporation's steel mills in the region, thousands of miners and their steelworker allies attempted to shut down steel production in the area by closing the facility. In the process, they also hoped to attract support from the steelworkers employed at the Duquesne, Homestead, and Edgar Thomson Works. The effort failed when the Corporation managed to attract enough depression-starved workers into the mill to keep the coke works running and because the strike failed to spread beyond Clairton.[28]

The second attempt to overturn the ERP took place between 1934 and 1935 when an estimated 50,000 steelworkers spontaneously organized themselves into fifty new lodges of the Amalgamated Association in the Ohio and Monongahela valleys. The new lodges, which accepted steelworkers regardless of skill level, attempted to act in concert for the purpose of exacting union recognition from employers in the steel industry. Their efforts, however, were stymied by the refusal of the Amalgamated Association's national leadership to support a nationwide strike call. The Association agreed on what became an ill-fated strategy to negotiate a settlement with the steel companies for union

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[27]My evidence on the organizational makeup of the ERP's at U.S.Steel is drawn from the minutes of the Fifth and Sixth Joint Conference of Employees and Management Representatives - Duquesne Works, February 11 and June 2, 1936. The minutes can be found in the Industrial Relations Records of the Duquesne Works at the Labor Archives, University of Pittsburgh and are hereafter referred to as the Fifth and/or Sixth Joint Conference minutes of the ERP at the Duquesne Works.

[28]The Daily News, McKeesport, PA, September 28 - October 11, 1933; The Pittsburgh Post-Gazette, September 26 - October 11, 1933; A more complete account of the Clairton strike can be found in Joel Sabadasz, "Understanding Workers: Labor Relations in Steel from 1930 to 1941 in the Lower Monongahela Valley", manuscript in the possession of author.

recognition through federal mediation. A last-ditch effort to win recognition through direct action in the Monongahela Valley occurred on May 31, 1935 when William Spang, the leader of the Fort Dukane Lodge at the Duquesne Works, called a strike to support striking steelworkers in Canton, Ohio. The strike was short-circuited, however, when Spang and the other officers of the lodge were arrested by city authorities for parading without a permit.[29]

While early efforts to overturn the ERP at the Monongahela Valley steel mills failed over the intervening years, the actual experience of ERP steelworkers contributed to its eventual demise. The ERP became a school for independent industrial unionism. This was particularly evident at the Duquesne Works where the employee representatives grew increasingly frustrated over management's failure to fairly address worker grievances around such issues as the division of work time among the employees during the Depression, promotions, and the company's wage policy. The employee representatives who favored a system based on seniority complained bitterly about the practice of individual managers to promote workers based upon favoritism. Wage questions dealt with the inequities in wages paid for identical jobs in the different U. S. Steel mills in the region, the employees' quest for the establishment of a base rate of pay before tonnage incentives, and the application of a general wage increase.[30]

As it became clear that employee grievances at Duquesne could not be properly addressed through the ERP, employee leaders joined their counterparts at the Clairton Works in June of 1936 to lead a drive for the creation of a central body of employee and management representatives from each of U. S. Steel's Carnegie-Illinois Steel mills nationwide. The principle figures in this effort were Elmer Maloy, chairman of the employee representatives at Duquesne, John Kane, general secretary of the employee representatives at Duquesne, and John Mullen, chairman of the employee representatives at the Clairton Works. Although U. S. Steel resisted the move, the ability of these men to successfully organize employee representatives from the Pittsburgh, Youngstown, and Chicago districts, forced the company

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[29]Staughton Lynd, "The Possibility of Radicalism in the Early 1930's: The Case of Steel," Radical America 6(November-December, 1972): 37-64.

[30]Fifth and Sixth Joint Conference Minutes of the ERP at the Duquesne Works; Grievance Files of the ERP at the Duquesne Works in the Industrial Relations Records of the Duquesne Works at the Labor Archives, University of Pittsburgh.

to recognize the new body if it wanted to maintain control of employee-management relations. After the new organization had been set up, Maloy and Mullen openly joined the CIO's Steel Workers Organizing Committee (SWOC) to capture the company-wide ERP for independent unionism. Over the next several months, the two men, who were elected to the top employee representative posts in the new central body, worked skillfully to gain the support of their fellow representatives for pressing aggressive demands upon the Corporation. In the process, they demonstrated the inability, from the employees perspective, of trying to work within a company controlled industrial labor relations system. In January of 1937, the ERP at Carnegie-Illinois met for the last time. Meanwhile, SWOC representatives signed up 125,000 new members, many from the steel mills of Carnegie-Illinois. Two months later, U. S. Steel's employee-relations program was in shambles and labor problems prevented the company and employees from profiting from an upturn in the economy. The company finally signed a collective bargaining agreement with the SWOC in 1937.[31]

The new agreement positively addressed many of the concerns raised by employee representatives at the Duquesne Works. It called for a ten percent general wage increase, a guaranteed eight hour day, a forty hour work week provided work was available, and a seniority system for both promotions and layoffs. A five-step grievance procedure was also set up, providing for equal and exclusive representation of both union and management officials. The last step called for all unresolved disputes to be decided by a neutral umpire chosen by both parties. In the next few years, the union and company agreed on a common base rate of pay before tonnage incentives kicked in, and negotiated a wage classification system that standardized rates for a set number of job classifications throughout the industry in 1943.[32]

Plant and Community, 1918-1945

World War I, the Depression, and World War II all had significant influence on the relationship between the steelworks and the community of Duquesne. World War I caused a labor shortage and increased wartime production requirements. As

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[31]Bernstein, Turbulent Years, 459-67.

[32]"SWOC Agreement with the Carnegie-Illinois Steel Company of March 17, 1937" in the Industrial Labor Relations Records of the Duquesne Works at the Labor Archives, University of Pittsburgh; Mark McColloch, "Consolidating Industrial Citizenship: The USWA at War and Peace, 1939-46" in Forging a Union of Steel: Philip Murray, SWOC & the United Steelworkers, (Ithaca: 1987), 69-76.

hundreds of steelworkers left their jobs for military service, the demographic character of the city was significantly altered by the influx of African-American labor from the south. As a result, the African-American community grew to just over 1,800 or 8.5% of the city's population by 1930. The African-American influx was the last large migration of people into the city. After their arrival, the population of Duquesne reached its peak of just over 21,000.[33]

The significance of the Depression related to the changing character of the city's political leadership. Before the Depression decade, municipal government was controlled by Republican Party officials, many of whom had close ties to management circles within the steel industry. James Crawford, whose relationship to steel management circles is noted above, served as the city's mayor from 1917 until 1937. In addition, managers from the Duquesne Works regularly served on city council and the increasingly influential Duquesne Businessmen's Association. The Depression, however, undermined their authority and prestige. Steel mill officials were unable to provide the city's working-class residents with adequate employment or to continue the social welfare programs begun in 1914. Consequently, their standing within the community declined along with their standing within the mill. Furthermore, the fiscal conservatism to which local GOP officials subscribed came to be seen as a hindrance to recovery efforts, especially when compared to efforts in nearby communities. The governments of nearby Pittsburgh and McKeesport, for example, actively utilized New Deal public works programs administered by the Works Progress Administration (WPA) and Projects Works Authority (PWA) in an effort to provide work for unemployed residents and to improve the infrastructures of their communities. On the contrary, Duquesne officials declined to participate on ideological grounds.

As the standing of the city's traditional political leadership declined, the reputation of local unionists, especially Elmer Maloy, began to rise. In 1937 Maloy decided to run for mayor as a Democrat, challenging Republican political dominance. During the campaign, he identified himself closely with the New Deal programs of the Roosevelt Administration by stressing the responsibility of local government to protect the constitutional right of workers to participate in trade unions, and the importance of participating in federal public works

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[33]Dennis C. Dickerson, Out of the Crucible: Black Steelworkers in Western Pennsylvania, 1875 - 1980, (Albany: 1986), 57; The 1940 U. S. Population Census, Vol. 1: 159 gives population data for both 1930 and 1940.

programs. His Republican opponent R. W. Schreiber, on the other hand, called for a continuation of the 'business-like' principles that governed the city in the past. The result was a comfortable 345 vote victory (2959 to 2614) for Maloy who became the first Democratic Mayor in the city's history. In 1941, Maloy gained a second term with a 191 vote margin (3365 to 3213) over his Republican rival, Frank Kopriver.[34]

Maloy's tenure (1938-1946) was marked by the extensive use of WPA programs for the purpose of paving the remainder of the city's unpaved streets and by the DPC financed addition of the electric furnace and alloy bar heat treating plants to the steel mill's productive facilities. The latter had important consequences for the city's physical and political development because it necessitated the demolition of a portion of Duquesne's First Ward known as "below the tracks" in 1942. The demolition of the thirty-eight acre neighborhood, which encompassed fourteen city blocks and bisected the steel mill, forced the removal of 2474 residents. Many of the evacuees were eventually relocated in one of several federally-funded defense housing projects, many of which were located outside the city.

Although Maloy vigorously supported the construction of additional facilities at the Duquesne Works because of its job creating potential, the dislocation of many residents cost the Mayor his political majority. In each of his victorious campaigns, the basis of Maloy's political support came from the predominantly working-class neighborhood "below the tracks." Maloy's attempts for a third term were defeated by Republican Frank Kopriver in 1945.[35]

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[34]The attitude of Duquesne's GOP officials toward the New Deal as well as the extensive use of New Deal public works programs in Pittsburgh and McKeesport can be found in the city council minutes for those cities between 1933 - 1937; Maloy's platform and other Mayoral campaign details appear in The Daily News, McKeesport, PA, June 30, July 14, 15, 16, 19, 21, 23, 26, 29, 31, August 13, 14, 16, 17, 27, 31, September 1, 4, 7, 9, 10, 13, 15, 17, October 22, 25, 26, 27, 28, 29, and November 2, 3, 1937; Beth Shervey, "Steelmaking and the Growth of Monongahela Valley Mill Towns," 17-29; The election results of the 1941 mayoral race appear in The Daily News, November 5, 1941.

[35]For more detailed information on the demolition of the "below the tracks" neighborhood, the movement of "below the tracks" residents to homes outside of the city, and the political ramifications of these events see The Daily News, April 29, May 15, 27, June 19, 28, 30, July 1, 9, 11, 15, 16, 21, 24, 25, 28, 29, 30, August 9, 16, 18, 19, 20, 23, 25, 26, September 3, 5, 24, October

PART THREE: 1946-1988

Despite the addition of a modern electric furnace and heat-treating facilities, the Duquesne Works faced permanent shutdown after World War II because of its antiquated technology. However, the mill was saved from this fate by the successful introduction of innovative environmental equipment at its ferromanganese production facilities. It also provided the foundation for a massive modernization effort at the mill's ironmaking, steelmaking, and steelshaping facilities in the 1950s and early 1960s. This modernization program culminated in the linking of the Duquesne Works with the National Tube Works in McKeesport to provide semi-finished steel shapes for National's tube mills. During the 1970s and 1980s the technological development of the mill was dominated by the installation of environmental equipment.

Labor-management relations during the period were marked by escalating conflicts over the relationship between technology and work crew size. The high level of intensity that this conflict created at the Duquesne Works was shared throughout the industry on both sides of the issue.

The increasing focus on environmental technology also reflected both the growing concern of the outside community for a clean environment and its expanding influence over capital expenditures within the industry to meet regulatory requirement. In 1984, a depression in the domestic oil industry prompted U. S. Steel to permanently shut down the mill. Efforts by organized labor and community-based groups to reopen it were unsuccessful.

Technological Development, 1946-1984

After the end of World War II, the Duquesne Works entered a period of precipitous decline and was put on standby status because of aging equipment. The state of disrepair at the fifty year-old Open Hearth Number One steelmaking shop, for example, necessitated its complete shutdown in 1949. The mill's fifty year-old primary mill, moreover, was still powered by steam at a time when the more efficient and reliable use of electrical power for such operations had been commonplace in the industry for more than twenty years. In addition, the capacity of Duquesne's aging blast furnaces was quite small by contemporary standards. Considering these factors, employees should not have been surprised when they were informed by plant officials during a company outing at nearby Kennywood Park in the early 1950s that

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9, 16, 20, 23, 28, and November 8, 1941; Election results for the 1945 Mayoral election can be found in The Daily News, November 6, 1945.

the plant might be closed for good.[36]

Adding to the uncertainty of the mill's future was the enactment of smoke control legislation by Allegheny County in 1949 which threatened its ability to produce ferromanganese. A common alloy in steelmaking, ferromanganese was produced for consumption by U. S. Steel's Monongahela Valley mills at the blast furnaces of the corporation's Isabella Furnace Plant, Clairton Works, and Duquesne Works. A necessary by-product of ferromanganese production was a dense, pyrophoric fume which could not be entirely cleaned by conventional gas cleaning methods. Consequently, much of the fume or flue dust had to be emitted into the atmosphere through blast furnace bleeder stacks. Under the terms of the smoke control ordinance, however, this practice was precluded by stringent requirements that limited the amount of flue dust admitted legally into the atmosphere to .5 or less pounds per 1,000 pounds of gas produced. As a result, U .S. Steel was faced with the choice of developing a comprehensive system of cleaning ferromanganese gas or abandoning production of the product in Allegheny County. The corporation experimented with several methods of cleaning the gas with only limited success. Finally, a successful pilot plant was built at the Isabella Furnaces that both cleaned the gas and sintered the flue dust into briquettes. A full-scale system was built at the Duquesne Works in 1953. The great expense of building and maintaining the system combined with the negligible reuse value of the flue dust (i.e. the briquettes could not be recharged back into the furnace because of their high alkali content), induced the corporation to centralize its Monongahela Valley ferromanganese production facilities at the Duquesne Works. With this decision, U. S. Steel insured the immediate future of the mill as a productive facility.[37]

In the years following the installation of the ferromanganese gas cleaning facility, the works underwent a

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[36]Kenneth Warren, The American Steel Industry, 1850-1970: A Geographical Interpretation, (Pittsburgh: 1989), 287; Duquesne Works, Steelmaking Division. "Steel Production Conference," 1; Reference to the Kennywood Park announcement about the possible closure of the Duquesne Works can be found in U. S. Steel Chairman Edgar Speer's "U. S. is Being Legislated into a No Growth Society," Pittsburgh Post-Gazette, June 8, 1976.

[37]"Ferromanganese Cleaning Plant Starts Up on Duquesne Furnace," Iron and Steel Engineer 30(August 1953): 136, 139; C. H. Good Jr., "Ferromanganese Furnace Fumes Cleaned Successfully," Iron Age 170(July 8, 1954): 95-7; "Duquesne Streamlines Ferro Operations," U. S. Steel News 21(July 1956): 29-31.

massive modernization program beginning with a major upgrading of its ferromanganese production and delivery facilities.[38] This was followed by an expansion of the mill's electric furnace plant in 1956-57 which strengthened the relationship between the Duquesne Works and the Homestead Works. The plant's three original electric furnaces were enlarged, and two new furnaces and the nation's first vacuum casting chamber were installed. Vacuum casting was significant because it extracted harmful gases, particularly hydrogen, from molten steel prior to the formation of the ingot. Under conventional casting methods, these gases sometimes formed cavities or fissures in the ingot, making it susceptible to internal ruptures. The successful use of vacuum casting at Duquesne's electric furnace plant, consequently, made possible the delivery of high-quality ingots to the Homestead Works, where they were forged into shapes that met the stringent strength requirements of the electrical generator, aircraft, and space industries.[39]

After completing modernization efforts which solidified Duquesne's ties to U. S. Steel's other Monongahela Valley steel mills, corporate officials moved to improve the technological basis of the mill's traditional product line by authorizing a major reconstruction of the remainder of its ironmaking, steelmaking, and steelshaping plant. This began with the replacement of the Works' antiquated blooming and billet mills with new facilities in 1959. The new primary mill was one of the most versatile in the nation at the time it was built. Operated and controlled by computer, the fully automatic mill was capable of producing slabs, two sizes of blooms (46" and 36"), and billets. An important aspect of the new mill was a computerized data collection system which provided up to the minute

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[38]"Ferromanganese Production Doubled," Blast Furnace and Steel Plant 41 (October 1953): 1207; "Rebuilt Blast Furnace Number Three Begins Tenth Campaign at Duquesne Works," Iron and Steel Engineer 30 (August 1953): 149; "Duquesne Streamlines Ferro Operations," 29-33.

[39]United States Steel Corporation, "Five Furnace Shop Layout - Step 1 - 325'-0" Extension South - 112'-0" Extension North - Electric Furnace Building - Electric Furnace Plant: Drawing #28771, March 8, 1957"; "Add Electric Furnace at Duquesne Works," Iron and Steel Engineer 35 (April 1958): 170-1; "Add Electric Furnace at Duquesne Works," Iron and Steel Engineer 36 (January 1959): 167; "Duquesne Works Installs Vacuum Casting Process," U. S. Steel News 21(July 1956): 43; and "Vacuum Castings Made at Duquesne Works," Blast Furnace and Steel Plant 45 (December 1957): 1455.

information on production performance.[40]

Modernization of the mill's ironmaking facilities began in the mid-1950s with the construction of a new raw materials handling and storage system for the blast furnace ore yard. The system encompassed the coordinated use of a rotary car dumper, a conveyor belt and tripper system, and a modern 15-ton capacity ore bridge. A particularly significant addition to Duquesne's ironmaking facilities was the construction of the 'Dorothy Six' blast furnace in 1962. Built to replace Blast Furnace Numbers Five and Six, which were dismantled in the late 1950s, the new furnace had a slightly larger working volume (49,568 cu. ft.) than the combined working volume of the furnaces it replaced (49,540 cu. ft.). Dorothy Six was reported to be the most technologically sophisticated blast furnace in the world at the time of its construction. Included among its notable technological features were a computer operated automatic raw materials delivery system, two tap holes, and eleven recording probes placed at different levels on the furnace to give operators valuable information about both the composition and temperature of gases within the furnace. The data provided by these probes was expected to improve production and give engineers vital information with respect to future blast furnace design.[41]

In 1963, the modernization of the mill's productive facilities was rounded out by the construction of a basic oxygen steelmaking plant containing two 150-ton capacity converters. Although basic oxygen steelmaking had been used at smaller firms within the country for about a decade, the construction of the plant at Duquesne marked its first use by one of the 'big three' steel companies (U.S. Steel, Bethlehem Steel, and Republic Steel). The basic oxygen process combined the advantages of open-hearth and Bessemer steelmaking in that it was capable of producing many grades of steels in quantities comparable to the

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[40]"New Primary Mill at the Duquesne Works, United States Steel Corporation," Iron and Steel Engineer 40 (June 1963): 80-6; Harold E. McGannon, ed., The Making, Eighth Edition, 640-44.

[41]Heyl and Patterson, Inc., "Operating Instructions for Car Dumping and Ore Handling System at the Duquesne Works, Duquesne, Pa.," (Pittsburgh: 1958); American Iron and Steel Institute, Iron and Steel Works Directory, (New York: 1967), 284; "Novel Equipment Features U. S. Steel's New Duquesne Blast Furnace," Iron and Steel Engineer 40 (July 1963): 146-50; "Duquesne Works, No. 6 Blast Furnace," Blast Furnace and Steel Plant 51 (September 1963): 780-2; "A 'Lady' Grows in Pittsburgh," U. S. Steel News 27 (January-February 1962): 15-6.

open-hearth process at a rate comparable to the faster Bessemer process. The cost of production was more than $10 less per ton under the basic oxygen process than under the basic open-hearth process. As a result, open-hearth production was abandoned shortly after the new plant was constructed.[42]

Complementing the construction of the basic oxygen steelmaking plant was the installation of a modern high-purity gaseous oxygen making plant that also served the oxygen needs of the Clairton, Edgar Thomson, and Homestead Works by means of a 4.5-mile pipeline. Built and operated by the Linde Air Division of the Union Carbide Corporation, the plant was capable of producing 1,365 tons of oxygen per day. The centralization of oxygen production facilities at Duquesne induced company officials to create a central energy management facility on the site in an effort to make its Monongahela Valley steel mills more energy efficient. Tucked away in a small 25' x 80' room on the second level of No. 2 Power House and operated by twelve employees, the computerized Mon Valley Energy Management System monitored and managed the use of oxygen, natural gas, blast furnace gas, coke oven gas, mixed gas, No. 2 and No. 6 fuel oil, and electricity at each mill.[43]

In addition to the modernization efforts described above, important expansions to the works' heat treating facilities, 22" bar mill, and metallurgical testing capabilities occurred in the 1960s. The expansion of the heat treatment plant included the addition of two heat treating lines, a gas fired continuous line manufactured by Salem Brosius and an Ajax magnethermic electric induction line. The expansion of the 22" bar mill provided the operation with additional finishing and shipping facilities.

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[42]"Duquesne Works to Get First U. S. Steel Oxygen Converters," Iron and Steel Engineer 39 (September 1962): 161; "Oxygen at USS May Spur Steel Spending," Iron Age 190 (September 6, 1962): 43; "Modernization Program at Duquesne Works Marked by the Completion of Two 150-Ton OSM Furnaces," Iron and Steel Engineer 41 (July 1964): 201-04; "OSM Shop is Important Addition in Duquesne Works Expansion," Blast Furnace and Steel Plant 52 (August 1964): 719-21, 732; Pittsburgh Post-Gazette, August 30, 1962, May 13, 16, 1964; "U. S. Steel Shuts Down Duquesne Open Hearths," Blast Furnace and Steel Plant 53 (October 1965): 959.

[43]"New Uses Create Oxygen Boom," Iron Age 184 (October 1, 1959): 45; Harold E. McGannon, ed., The Making, Eighth Edition, 268; "Computer Directs Energy Management," The Bridge (A Newspaper of the National Duquesne Works), (December 1980): 3; Don Dvorsky, former General Manager of the Mon Valley Energy Management System, interview with author, March 9, 1990.

Finally, the metallurgical testing capability of the works was enhanced by the construction of a new testing laboratory. Employing the most modern testing equipment available, the new 'Met Lab' allowed technicians to conduct examinations of product characteristics with added speed and precision, thereby expediting delivery of orders to customers. In addition to testing materials produced in the mill, the modern facility also allowed on-site metallurgists to augment work being carried on at U. S. Steel's research center in Monroeville, Pennsylvania, regarding research into production problems and product improvements.[44]

Shortly after the modernization program at Duquesne was completed, the mill became the primary supplier of raw ingots to the Corporation's National Works in nearby McKeesport, Pennsylvania. This happened because the increasingly archaic iron and steelmaking facilities at the National Works threatened its competitive position as one of the nation's leading producers of tubular products for the domestic oil and gas industries. As a result, the blast furnaces and open-hearth shop at the National Works were shut down in 1965, giving way to the more modern facilities at Duquesne. Four years later, the link between the two mills was made permanent as their operations were combined and put under one management, the National-Duquesne Works.[45]

In the years following the creation of the National-Duquesne Works, market inroads made by foreign steel producers caused the Duquesne site to become increasingly dependent on the ability of National to produce tubular products than on its own ability to produce specialized semi-finished blooms, billets, and bars. By 1982 well over 50 percent of its semi-finished shapes were shipped as blooms to the pipemaking facilities in McKeesport. As a result, Duquesne's bar producing capabilities declined drastically. Only the 22" bar mill remained in operation after the mid-1970s.[46]

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[44]Pittsburgh Post-Gazette, August 30, 1962, November 3, 1964; "Will Build Laboratory at Duquesne." Blast Furnace and Steel Plant, Vol. 45, No. 3, (March 1957): 355.

[45]"U.S. Steel Makes Plant Changes," Blast Furnace and Steel Plant 53 (November 1965): 48; "Duquesne and National Being Combined," Blast Furnace and Steel Plant 57 (February 1969): 173; Warren, The American Steel Industry, 287.

[46]John P. Hoerr And the Wolf Finally Came: The Decline of the American Steel Industry, (Pittsburgh: 1988): 140; Steve Chomanics, Maintenance Foreman, interview with author, July 18, 1989.

Nevertheless, the robust condition of the domestic oil industry in the 1970s resulted in large profits for U.S. Steel and kept the works operating near full capacity. The profitability of the mill during this period had a significant influence on the decision by corporate officials to include Duquesne in an $600 million investment that resulted in a major upgrading of U.S. Steel's water and air purification technology at its Monongahela Valley mills. The impetus for this investment came from the increasingly stringent air and water quality standards mandated by the federal Clean Air and Clean Water Acts of 1963 and 1972 respectively.

In the case of water quality, federal standards were implemented to control the amounts of suspended solids, cyanide, ammonia, phenol, oil, and grease in water that was discharged into the river daily from iron and steelmaking gas cleaning systems as well as from rolling mill operations. The stringency of federal standards severely limited the amount of toxic substance that could be discharged into the river and forced the construction of water quality control facilities to recycle a great majority of the process water used in these systems. Because the suspended solids, scale, and other substances inherent in the process water also tended to plug up the equipment used in gas cleaning and cooling water systems if left untreated, the introduction of new water quality control systems required a great expenditure of money into the research and development of technology for chemically treating the water in order to make it recyclable.

The novelty of the technology meant that the installation of early recycle water purification systems were highly experimental in nature. This was particularly evident at Duquesne where a water quality control system constructed in 1979 at the blast furnace plant was forced to shut down after less than one year because the amount of process water it discharged into the river in order to keep the system's equipment clear of suspended solids exceeded federal limits. As a result, an entirely new and more successful system was constructed at the plant in 1980. In 1981 another successful water quality control system was installed at the works' rolling mill facilities.[47]

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[47]John P. Hoerr <u>And the Wolf Finally Came</u>, 137-40; "USS to Build Blast Furnace, Install Environmental Equipment," <u>Iron and Steel Engineer</u> 57 (March 1980): 69; Samuel P. Hays, <u>Beauty, Health, and Permanence: Environmental Politics in the United States, 1955-1985</u>, (New York: 1987), 77-80; United States Steel Corporation, Engineering/Research Division, "Operation Manual For WQC Recycle System, Duquesne Blast-Furnaces: Project No. 536-4366", (Monroeville, PA: 1979), 1-1 - 1-7, 2-1 - 2-35; Wayne Cadman,

The installation of improved air quality control systems at Duquesne occurred primarily at the mill's electric furnace and basic oxygen steelmaking plants during the early 1970s. Both installations were major extensions to previous air quality control systems constructed in the early 1960s and both were constructed because the original air purification facilities fell far below local and federal standards regulating the amount of particulate matter which could be emitted into the atmosphere from industrial sources. The electric furnace plant, for example, was releasing five or six times the amount of permitted air pollution in 1970. In an effort to correct this problem, the original dry cleaning system was expanded by embedding four additional large hoods in the roof structure of the furnace building for collecting airborne discharges from the five electric furnaces. The hoods conveyed the fume through duct work to an enlarged bag house where the solid particles from the smoke were filtered by fiberglass bags. The extension to the basic oxygen plant consisted of doubling the capacity of its existing wet gas cleaning system.[48]

Notwithstanding the prodigious amounts of money invested in modernizing the Duquesne Works between 1953 and 1981, the fortunes of the mill took a dramatic turn for the worse when the bottom dropped out of the domestic oil and gas producing industries in the early months of 1982. The basis for the boom in domestic oil and gas production resulted from the creation of the Organization of Petroleum Exporting Countries (OPEC) in 1973. Until its creation, oil sold on the world market for as little as $2.10 a barrel. After the founding of OPEC, however, the price of oil rose dramatically, reaching $34 per barrel in 1981. This price increase allowed the U.S. oil industry, which had significantly higher production costs than other oil producing countries in the world, to compete very favorably on the world market. As a result, there was an immense demand for oil well

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General Superintendent of Plant Utilities, interview with author, August 4, 1989; United States Steel Corporation, Engineering/Research Division, "Operation Manual for WQC Facilities, Non-Evaporative Recycle System, Blast Furnace No. 6: Project No. 501-7565," (Monroeville, PA: 1980), 2-1 - 2-35; Metcalf & Eddy, Inc./Engineers, "Operation Manual, Rolling Mills Division, Primary and Bar Mills, Wastewater Recycle Facilities: U.S. Steel Duquesne Works," (Boston, MA: 1981), 2-1 - 2-9.

[48]"Duquesne Works Constructing U.S. Steel Developed Smoke-Filtering System," Blast Furnace and Steel Plant 39 (March 1961): 268; Pittsburgh Post-Gazette, June 30, September 12, 1970, March 18, 1971, January 14, 1972, December 4, 1973, March 30, June 11-12, 1974.

pipe. However, when the price of oil dropped precipitously to as low as $15 per barrel in 1982, the domestic oil industry was put into a non-competitive position and declined drastically. U.S. Steel was left with a large tonnage of pipe which could not be sold. The decline of the domestic oil industry was particularly devastating for Duquesne, as production dropped to just 40 percent of its capacity by late April. The diminished nationwide demand for tubular and other steel products continued over the next two years, prompting corporate officials, in an effort to recoup losses, to take a big tax write-off on the company's assets and close a number of mills by the end of 1984. Included among them was the Duquesne Works which was permanently shut down in the Fall of 1984.[49]

Technology and Labor, 1946-1984

Between 1946 and 1959 industrial relations at the Duquesne Works was riddled with strikes. The mill's workforce participated in the nationwide steel strikes of 1946, 1949, 1952, 1956, and 1959. With the exception of the latter year, these strikes were conducted in support of union demands for increased wages and benefits. They resulted in making the steelworkers among the highest paid industrial workers in the nation.

The 1959 strike, on the other hand, focused on the relationship between technological development and the job responsibilities and size of work crews. At issue was the interpretation of a clause (Section 2-B) which had been first negotiated between the United Steel Workers of America (USWA) and the United States Steel Corporation in the collective bargaining agreement of 1947. Section 2-B protected work practices and crew sizes that had become embedded in local custom but gave management the right to change those practices when the 'basis' for them had been 'changed or eliminated'. Over the next several years, however, union and management officials could not come to a common agreement as to what constituted a legitimate reason for overturning past practices and/or work crew sizes. As a result, numerous time-consuming and costly grievances were filed by the union over the issue. The ambiguity of the clause's language appeared to be finally resolved by a series of arbitration rulings in 1953. These policies determined that the company could change the number of workers on a specific operation without violating the terms of the contract only by installing new equipment or technology or otherwise changing the 'underlying circumstances' of the job.[50]

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[49]Hoerr, And the Wolf Finally Came, 137-140; 437-42.

[50]Hoerr, And the Wolf Finally Came, 101; 325-26; David Brody, "The Uses of Power I: Industrial Battleground," Workers in

Despite the apparent clarification, company and union officials continued to disagree over the proper interpretation of Section 2-B. This was particularly true of the skilled craftsmen in the industry who jealously guarded their jurisdictional rights. The intensity of the conflict over the issue was amply demonstrated by the events which took place at the Duquesne Works during a period of slack operations in 1958-59. Spurred by fears of unemployment, the works' skilled craftsmen became increasingly upset over changes in work practices which they believed threatened the security of their jobs. Their grievances reflected three specific concerns: the impact of the development of new materials technology on work practices, the growing prevalence of outside contracting, and the question of using non-craftsmen or unauthorized craftsman to do work which fell within the jurisdiction of specific craft groups. In an effort to resolve the concerns of the craftsmen, management and union officials representing the various crafts on the site conducted a series of meetings in the fall of 1958.

The first issue--the development of new materials technology--primarily affected the mill's bricklayers and carpenters. Long accustomed to repairing soaking pit and heating furnace walls at the primary and bar mills, the bricklayers complained that this class of work had been recently turned over to production laborers. Management defended the new work practice by arguing that the development of cheaper and more easily installed plastic cast materials changed the underlying circumstances of the job. In other words, the materials, which could be simply rammed or pressed into those areas of the soaking pit or furnace walls that needed repair, obviated the necessity of the bricklayers' skills. A major grievance of the carpenters centered on the use of workmen other than themselves to hang newly developed prefabricated scaffolds. Until their development, scaffolds had been customarily built in the carpenter shop and hung by the carpenters throughout the mill. The prefabricated scaffold, according to management, was new and completely different from any type of scaffold previously used at the works. Because of the simplicity of the scaffold's design, the carpenters' specialized skills were no longer required to hang them.

Objections to outside contracting were particularly evident among the skilled employees of the tractor and electric repair shops. Mechanics from the tractor repair shop, for example, argued that overhaul and/or reboring work on engines from the mill's mobile equipment should be done in their shop instead of by outside contractors. Likewise, electricians from the electric

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Industrial America, 195-96.

repair shop resented the fact that the repair of small motors was conducted by outside contractors rather than by themselves. In both instances, management defended its practice of contracting out these types of work on the grounds of practicality. Because of the small amount of engine reboring work required at the Duquesne Works, management argued that it was not practical to purchase an expensive reboring machine for the tractor repair shop. On-site engine rebuilding required a prohibitively expensive inventory of spare parts to cover the varied types of mobile equipment at the works. Using a similar argument with regard to the repair of small motors, management cited the expense of carrying an inventory of parts for the numerous variety of small motors used at the works and the fact that outside shops were more properly equipped to perform this type of work.

The third concern--the question of using non-craftsmen or unauthorized craftsmen to do work falling within the jurisdiction of specific craft groups--was shared by nearly every tradesman in the mill. Painters complained that production workers in the bar mills were performing work that properly belonged to themselves. Pipefitters objected to the reduction of regularly assigned men in the bar mills after April of 1957 from seven to three workers and suggested that much pipefitting work in this area as well as throughout the mill was being performed by millwrights. The alleged practice of using millwrights to perform work which legitimately belonged to other craft groups also incurred the wrath of the mill's riggers. They complained that work such as the installation of a new crane monorail at the electric furnace plant was being conducted by the millwrights at their expense. Management, for its part, replied to these objections by observing that the lines between craft and non-craft work as well as between different kinds of craft work were often blurred but stated that it would do all it could to plan job assignments which would satisfy all craft groups within the mill.[51]

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[51]Minutes of Special Meeting Between Members of U.S.W. Local #1256 Grievance Committee, Representatives Maintenance Shop Employees, and Management of Duquesne Works, (October 17, 1958); Minutes of Special Meetings Between Duquesne Works Management and Members of U. S. W. Local 1256 Grievance Representatives of the Masonry Department Employees (November 17, 1958), Carpenter Shop Employees (October 23, 1958), Pipe Shop Employees (November 13, 1958), Locomotive and Tractor Shop Employees (November 5, 1958), Electric Repair Shop Employees (October 28, 1958), Paint shop Employees (November 6, 1958), and Rigger Shop Employees (October 31, 1958); Pipefitter Work Stoppage (May 21, 1959). All documents are in the Industrial Relations Records of the Duquesne Works at the Labor Archives, University of Pittsburgh.

Although the series of meetings described above gave union and management representatives a forum in which to present their views of the problems associated with craft work assignments, it did little to resolve the growing dispute. As a result, tensions between the two groups smoldered through the winter and spring of 1959. Finally, on May 21, the dispute reached a crisis point when management eliminated the regular work assignments of the three pipefitters in the bar mills. Pipefitter mill-wide responded to this action by walking off the job. They were soon joined by the works' riggers and welders. All in all, 340 craftworkers participated in the wildcat strike which ended on May 23 under an arrangement whereby management agreed to meet with union representatives and some of the men involved in the strike to discuss their complaints. The results of this meeting only continued the stalemate as management asserted its exclusive right to assign pipe shop employees when and where necessary. Union officials, moreover, were instructed to follow regular grievance procedures if they wished to contest the issue.

During the strike and its aftermath, company officials took elaborate steps to identify and punish the leaders of the walkout. They photographed all pickets, took depositions from lower level managers who were directly responsible for assigning work to the striking craftsmen, and compiled detailed dossiers on workmen identified as strike leaders. Company officials then proceeded to develop a coordinated strategy from which they could confront the union local's leadership and the strike leaders. Speaking in generalities, management notified union representatives and the alleged strike leaders that they had overwhelming evidence implicating the accused of orchestrating a walkout and suggested that the men involved confess to their role in the affair if they wished to avoid the sternest punishment. As a result, the men in question, Edward Hunt, Henry Harff, and Edward Revak, admitted to leading the strike in return for a lengthy suspension from work without pay.[52]

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[52]Pipe Fitter Work Stoppage (May 21, 1959); Events Leading to Walk-Out - Thursday, May 21, 1959; Pipefitter Strike Log (May 21, 1959); Strike or Work Stoppage Report - Form A (June 4, 1959); Memorandum of Meeting With Maintenance Shops & Gangs (June 9, 1959); Photographs of Pickets During Pipefitters Strike of May, 1959; Dossiers of Edward B. Hunt, Henry Harff, and Edward Revak; Proposed Procedure With Respect To The Discipline In Connection With The Pipefitter Work Stoppage (May 27, 1959); Memorandum Of Meeting With Union On Pipefitter Strike Disciplinary Action (May 28, 1959); Letter from J. Warren Shaver, Assistant Vice President of Industrial Relations for the United States Steel Corporation to Paul M. Hilbert, Director, District Fifteen, United Steelworkers of America (June 16, 1959). All documents are in the Industrial

The animosity displayed between management representatives and union officials over the interpretation of Section 2-B at the Duquesne Works clearly reflected the state of affairs in the steel industry nationwide. Less than two months after the pipefitters' wildcat strike at Duquesne, the United Steelworkers of America struck the entire industry when management representatives, in an unquestionable reference to Section 2-B, demanded an end to language that had "frozen inefficiency and waste in the operation of steel production." Ironically, before the industry's demands the union's national leadership was confident that contract negotiations could be conducted successfully without the need for a strike. Yet, when management's position became known to the union's rank and file, the national leadership, in recognition of the members militant stance on the work practices issue, had no choice but to call a walkout. The strike, which lasted a record setting 116 days, ended in a significant victory for the union as Section 2-B remained in force within the new contract.

Despite the union's victory, tensions over the effect of Section 2-B continued to haunt labor-management relations throughout the industry. This was particularly true with regard to the massive plant shutdowns of the United States Steel Corporation in the early and mid-1980s. When corporate officials first announced in 1983 that they would permanently close down a large number of mills throughout the nation, they stated that the identity of the mills in question might be determined, to a greater or lesser degree, by the ability of various local unions to cooperate with the corporation in developing new work practices and a new craft system. In response, a number of union locals throughout the nation, fearing the imminent shut down of their workplaces, agreed to workforce concessions. Union representatives at the Clairton Works, for example, agreed to eliminate sixty jobs by reducing crews at each of the mill's coke batteries from twenty-one to fifteen workers. The new leverage U.S. Steel possessed on work practices issue was especially evident at the Fairfield Works in Birmingham, Alabama. Union officials there agreed to eliminate all past practices with respect to manning, crew sizes, and job assignments while giving management the unilateral right to establish new practices.

U.S. Steel was so pleased with the concessions it gained from the Fairfield agreement that it became the corporation's model for negotiating with other mills. Not all local union officials, however, were willing to make the compromises that were made at Fairfield. Many were outraged because they believed

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Relations Records of the Duquesne Works at the Labor Archives, University of Pittsburgh.

that the agreement effectively revoked the industry-wide agreement regarding Section 2-B. If one local could ignore an industry-wide agreement, they feared, the union could dissolve into numerous competing locals.

One man who shared this point of view was Mike Bilcsik, the president of the United Steelworkers of America Local Union #1256 at the Duquesne Works. Bilcsik, who believed that the union should be flexible on the work practices issue, had tried unsuccessfully to convince Duquesne's management to set up a Labor Management Partnership Team (LMPT) in 1982 to deal with the issue. However, when corporate officials told him in 1983 that his local had to agree to a reduction in crew sizes in order to make the mill competitive, Bilcsik replied that he would negotiate on the issue only in return for a guarantee that the company would invest in the modernization of the mill. Refusing to agree to Bilcsik's proposal, the company cut off negotiations with the local. Although the permanent shutdown of the Duquesne Works was clearly due to the depression in the primary market for its steel--the domestic oil and gas pipe industry--tensions over Section 2-B plagued labor-management relations until the mill shutdown.[53]

Plant and Community, 1946-1984

The relationship between plant and community during the post World War II period turned, to a large extent, on a tripartite interaction between community and regional activists, corporate officials, and the local, state, or federal government with respect to the regulation of the mill's affairs. This interaction produced dramatic improvements in the environmental qualities of the community. However, after 1984 when community activists sought to draw on this relationship to extend its power and influence, they found that their effort to save the Duquesne Works from permanent shutdown exceeded the accepted bounds of economic possibility.

The development of an effective tripartite coalition that focused on improving the Monongahela Valley's environment through the control of industrial wastes began in February of 1941 with the creation of the Mayor's Commission for the Elimination of Smoke in Pittsburgh, Pennsylvania. The commission was the outgrowth of the successful efforts in the late 1930s of several prominent citizens and civic organizations to garner public support for ideas promoting the social and economic value of cleaner air in the city. It consisted of representatives from business, organized labor, local government, the media, the

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[53] Brody, "The Uses of Power I: Industrial Battleground," 195-98; Hoerr, And the Wolf Finally Came, 101, 262, and 438-42.

health professions, and voluntary associations. The commission prepared an ordinance--passed by city council in July--that required the elimination of industrial smoke through the use of smokeless fuels or by the application of smokeless mechanical equipment by October of 1941. Although the compliance date was eventually waived because of the War, the issue was kept alive by the creation of a new organization, the United Smoke Council (U.S.C.), consisting of eighty organizations from Pittsburgh and Allegheny County. The U.S.C. gained an important ally when the Allegheny Conference on Community Development (A.C.C.D.) joined forces with it at the end of 1945. Composed of leading businessmen from the region's major banks and corporations, the A.C.C.D. recognized the importance of environmental improvements in revitalizing the Pittsburgh Central Business District and ultimately the regional economy. As a result of their combined efforts, a new enforcement date for the elimination of industrial smoke was set for October 1, 1946. This was followed in 1949 by the enactment of a county-wide law embodying the principle features of the Pittsburgh ordinance. In order to comply with the county-wide statute, industry in Allegheny County spent over $200,000,000 by 1956 on the installation of modern combustion equipment, dust collectors, new boiler plants, precipitators, and other devices to eliminate smoke and other industrial pollution.[54]

Significant among the newly installed anti-pollution equipment was a ferromanganese gas cleaning plant at the Duquesne Works. The new law made it imperative that all future modernization projects at Duquesne provide for the installation of smokeless equipment. Consequently, new facilities, such as the basic oxygen steelmaking plant in 1963, were said to have the most modern gas cleaning and emission equipment in the nation at the time of its construction.[55]

Despite efforts to comply with emissions requirements, the increasing stringency of federal and local environmental laws as well as the poor performance of some of the smoke control

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[54]Joel A. Tarr and William Lampres, "Changing Fuel Behavior: The Pittsburgh Smoke Control Movement, 1940-1950 and Energy Transitions Today - A Case Study in Historical Analogy," Journal of Social History 14 (Summer 1981): 561-73; Park H. Martin, "The Renaissance: A Catalogue of Projects," Pittsburgh, Ed. by Roy Lubove, (New York: 1976), 213.

[55]See section "Technological Developments, 1946-1984," for a discussion of the impact of the ferromanganese gas cleaning plant on the technological development of the Duquesne Works; "OSM Shop Is Important Addition In Duquesne Works Expansion," 720-21.

equipment at the Duquesne Works created an atmosphere which provoked much conflict between corporate officials, county enforcement agencies, and environmental activists in the years succeeding the 1949 county-wide ordinance. The resolution of one such conflict, a controversy over the performance of air quality control equipment at the mill's electric furnace plant in the early 1970s, demonstrated the creative ways in which a public/private coalition could work together to solve common community problems.

The controversy began in 1961 when the installation of an air cleaning system at the recently expanded electric furnace plant proved far too small for the task at hand. As a result, the plant emitted five to six times the amount of air pollution permitted by county law in 1970. This violation prompted local environmental organizations like the Group Against Smog and Pollution (GASP) to call public attention to the problem. After a careful study of conditions at the Duquesne Works, the Allegheny County Air Pollution Control Bureau ordered U.S. Steel to comply with the county's air pollution control law by December 31, 1970. In response, corporate officials requested an indefinite variance, claiming that there was no known practical method for controlling electric furnace smoke and particulate emission. This caused an uproar as representatives from GASP charged that the corporation had been stalling for years on serious anti-pollution measures at the Duquesne Works.

Finally, after several months of negotiation, the bureau's appeal board granted a variance until July, 1971, when the company agreed to install an extensive smoke evacuation system at the electric furnace plant. In addition, the county agreed to finance the construction of the new air pollution control system with a $ 5 million loan through its Industrial Development Authority. The money was raised in the form of bonds which were sold by the county to a private securities firm. The firm, in turn, sold the bonds to individual investors under an arrangement whereby U.S. Steel paid off the principle and interest on the bonds through the payment of rental fees over a fifteen-year period.[56]

The successful examples, described above, of public/private efforts to enhance Allegheny County's air quality in the post-war period ultimately provided a model for labor and community activists to make a last ditch effort to reopen the Duquesne Works after U.S. Steel permanently shut it down in the fall of 1984. This effort had actually begun in 1983 when USWA Local

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[56]The Pittsburgh Post-Gazette, June 29, 30, September 2, November 16, 1970, March 18, 1971, and January 14, 1972.

Union #1256, under the leadership of Mike Bilcsik, began exploring ways to secure the mill's productive future. Sensing that the works was in imminent danger of permanent closure, Bilcsik told the local's membership that the mill could be kept open if they bought it from the corporation through the establishment of an Employee Stock Ownership Plan (ESOP). Although an example of a successful ESOP existed at the nearby West Virginia facilities of Wierton Steel, the plan never got off the ground at Duquesne because of traditional biases among union members which held that ESOP's were either used as a means to bust unions or to allow companies to pass on liabilities.

Hopes for saving the mill were revived in the fall of 1984 through the activities of the Tri-State Conference on Steel, a non-profit, public interest group. Composed of political and church activists, Tri-State was organized in 1979 to save threatened manufacturing plants in eastern Ohio, northern West Virginia, and western Pennsylvania from permanent closure. In 1981, after failing to halt the spate of steel mill closings in Youngstown, Ohio, the organization moved into the Pittsburgh area where it worked to organize a strong grass roots foundation to attract politicians and private institutions to its cause.

The impetus for Tri-State's campaign to save the Duquesne Works occurred in October of 1984 when U.S. Steel announced plans to demolish the hot end of the mill in November. Shortly thereafter, the organization joined forces with Local Union #1256 and the national leadership of the USWA in what was dubbed the "Save Dorothy" campaign. The basic plan involved buying the Dorothy Six blast furnace, the basic oxygen shop, and the primary mill for operations as a worker-owned establishment. To this end, the coalition was able to attract financial support from the Allegheny County Board of Commissioners and the Pittsburgh City Council for a $150,000 preliminary feasibility study by Locker/Abrecht Associates of New York. Under mounting pressure from labor and community activists and politicians, U.S. Steel agreed to postpone its demolition plans until February 2, 1985.

While the study was conducted, the coalition redoubled its organizing campaign. A mass rally, held just outside the main plant gate on January 18th, featured Jesse Jackson as the main speaker. Joining him at the podium were State Representative Thomas Michlovic of North Braddock, USWA international vice-president Leon Lynch, and mayor of Pittsburgh Richard Calguiri. Support from local, state, and federal politicians for the effort dramatically increased when the results of the Locker/Abrecht study were released on January 28th. Contradicting U.S. Steel estimates which put restoration costs at $500 million to make the mill competitive, the Locker/Abrecht study found that the mill could profitably market semi-finished steel shapes with $90 million in start-up and operating costs over the first three years if it cut its labor force by 30 percent. According to the study, the mill could become 'super competitive' if $150 million were raised to build a continuous caster.

Armed with the favorable results of the Locker/Abrecht study, the coalition pressed for a second postponement of demolition while a final feasibility study was conducted by Lazard Freres & Company of New York. In response, USS Chairman David M. Roderick agreed, in a meeting with the County Commissioners and U.S. Representative Joseph M. Gaydos, to delay demolition until the corporation had thoroughly reviewed the Locker/Abrecht report and until further discussions were held with the commissioners. Doubting the chairman's word, members of Local Union #1256 maintained an around-the-clock watch of the plant's main gates to make sure that the company did not surreptitiously attempt to put a demolition crew into the mill.

As the final study was prepared, Tri-State concentrated it efforts on gathering support for the establishment of a Steel Valley Authority in each of the communities along the Monongahela and Turtle Creek valleys. Organized along the lines of a public authority, the Steel Valley Authority had the power of eminent domain under state law. This allowed it to acquire the land, buildings, and machinery of existing plants for economic development. Its establishment in communities like Duquesne provided the legal mechanism by which funds from private lending institutions could be procured to purchase and reopen closed industrial facilities.

Although Tri-State's effort resulted in the creation of a Steel Valley Authority in nine municipalities, the effort to save the Duquesne Works from permanent shutdown failed. The failure was caused by two factors. First, city officials in Duquesne, skeptical of the "save the mill" campaign from the start, and anxious to establish an industrial park on the former mill site, rejected all efforts to establish a local Steel Valley Authority. Second, and more importantly, the findings of the Lazard Freres study in January of 1986 proved irreconcilable with the coalition's efforts. According to the report, the mill could become competitive only if it installed a continuous caster. Following the Lazard Freres study, the total cost of rehabilitating the works would be in excess of $300 million. One prominent USWA official commented after reading the report that even if the employees worked for free, the mill could not make money. As a result, the coalition abandoned its effort, and Dorothy Six was demolished in August of 1988. A few days later, the corporation transferred ownership of the rest of the mill site to the Allegheny County Department of Development which seeks to develop it into an industrial park.[57]

Today, most of the structures on the site of the Duquesne Works, now known as the "City Center" of Duquesne, remain standing. In the seven years since the works was officially closed, the city has lost more than an estimated $1,000,000 per year in tax revenues. Since 1984, many of the small businesses which catered to the mill's workers have either closed or relocated outside of town. Duquesne's declining population is increasingly aged, as most of its young citizens have left the community in search of good paying jobs. According to projections by Allegheny County officials, it will take between fifteen and twenty years before the proposed industrial park will yield anything like the number of jobs available during the mill's heyday.[58]

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[57] The Pittsburgh Press, October 9, 1983; The Pittsburgh Post-Gazette, March 29, 1984; Hoerr, And the Wolf Finally Came, 582-86; William Serrin, "Pittsburgh Area Rallies to Save Blast Furnace," The New York Times, January 30, 1985; The Pittsburgh Press, January 17, 18, 1985; The Daily News, McKeesport, PA, January 28, 29, 1985; The Pittsburgh Post-Gazette, December 5, 1984; William Serrin, "Rally Presses Revival of Steel Plant," The New York Times, May 19, 1985; The Daily News, January 9, 1986; The Pittsburgh Post-Gazette, August 2, 1988.

[58] The Pittsburgh Post-Gazette, June 7, 1984; The Pittsburgh Press, November 17, 1983.

APPENDIX - DUQUESNE WORKS SITE INVENTORY

CONTENTS - DUQUESNE WORKS SITE INVENTORY

IRONMAKING- BLAST FURNACE PLANT

<u>Historic Name</u>: United States Steel Corporation, Duquesne Works, Blast Furnace Plant, Iron and Ferromanganese Production and Delivery System
<u>Present Name</u>: U.S.X. Corporation, National-Duquesne Works, Blast Furnace Plant, Iron and Ferromanganese Production and Delivery System
<u>Location</u>: Upper Works
<u>Construction</u>: 1896, 1962
<u>Documentation</u>: Photographs of the Duquesne Blast Furnace Plant located in HAER No. PA-115-A.

DESCRIPTION

I. <u>Blast Furnace Cooling Water Facilities</u>:

A. <u>Blast Furnace Number One Bosh Pump House</u>: The bosh pump house for blast furnace number one is located approximately 8'-0" west of cast house number one. The brick enclosure is approximately 10'-0" wide x 17'-0" long x 8'-0" high. Located within the center of the structure is a 125 hp, 1170 rpm Allis-Chalmers motor connected to a Wilson-Snyder pump rated at 5,000 gpm. The pump supplied cooling water to the hearth and bosh area of blast furnace number one. A start-up panel for the pump motor is located inside of the structure just south of the motor/pump assembly.
Construction of pump house: 1896.
Installation of motor/pump assembly and start up panel: 1961.

B. <u>Blast Furnace Number One Stack Pump House</u>: The stack pump house for blast furnace number one is located just south of the bosh pump house. The brick enclosure is approximately the same size as the bosh pump house. It contains a 40 hp, 1775 rpm Westinghouse Life-Line motor which is connected to a size 6 x 6 x 16 AL Wilson-Snyder pump operating at 1000 gpm. The pump supplied cooling water to the stack area of blast furnace number one.
Construction of pump house: 1896.
Installation of motor/pump assembly: 1963.

C. <u>Blast Furnace Number Three Bosh Pump House</u>: The bosh pump house for blast furnace number three is located approximately 8'-0" west of the cast house number three. The approximately 15'-0" wide x 17'-0" long x 8'-0" high brick enclosure contains two motor/pump assemblies. One assembly consists of a 125 hp, 1170 rpm Allis-Chalmers induction motor connected to a model 16 BA

Wilson-Snyder pump operating at 5,000 gpm. The other assembly consists of a 100 hp, 1780 rpm Westinghouse motor connected to a 6 x 6 x 16 ES Wilson-Snyder pump operating at 1,000 gpm. The pumps delivered cooling water to the hearth and bosh area of blast furnace number three.

Construction of pump house: 1896.
Installation of 5,000 gpm motor/pump assembly: 1958.
Installation of 1,000 gpm motor/pump assembly: 1967.

D. Blast Furnace Number Three Stack Pump House: The stack pump house for blast furnace number three is located just south of the bosh pump house. The approximately 10'-0" wide x 17'-0" long x 8'-0" high brick enclosure contains 100 hp, 1450 rpm motor connected to a model 8 x 6 SKD Allis-Chalmers pump operating at 1,000 gpm.

Construction of pump house: 1896.
Installation of motor/pump assembly: 1963.

E. Blast Furnace Number Four Bosh Pump House: The bosh pump house for blast furnace number four is located approximately 8'-0" west of cast house number four. The approximately 20'-0" wide x 17'-0" long x 8'-0" high brick enclosure contains a 150 hp, 1180 rpm Allis-Chalmers motor connected to a model 14 BA 2 Wilson-Snyder pump operating at 5,000 gpm. The pump delivered cooling water to the hearth and bosh area of blast furnace number four.

Construction of pump house: 1896.
Installation of motor/pump assembly: 1959.

F. Blast Furnace Number Four Stack Pump House: The stack pump house for blast furnace number four is located just north of the bosh pump house. The approximately 10'-0" wide x 17'-0" long x 8'-0" high brick enclosure contains the remains of two motor/pump assemblies, the main assembly and a booster assembly. The remains of the main assembly consists of a 100 hp, 1175 Westinghouse motor. The remains of the booster assembly consists of a 100 hp, 1770 Allis-Chalmers motor.

Construction of pump house: 1896.
Installation of main motor: 1970.
Installation of booster motor: 1958.

G. Dorothy Six Pump House: See inventory of the combustion air production and delivery system - section II - part M for building description. Located within the building are two bosh motor/pump assemblies, two hearth stave motor/pump assemblies, two stack motor/pump assemblies and four strainers. Each bosh motor pump assembly consists of a 200 hp, 1775 rpm General Electric Custom 8,000 motor connected to a model 10 x 12 x 14 1/2 DVC Wilson-Snyder pump operating at 4500 gpm. The bosh pumps provided cooling water to the tuyere coolers and bosh area of Dorothy Six. Each hearth stave motor/pump assembly consists of a 150 hp, 1770 rpm General Electric Custom 8,000 motor connected to a model 10 x 12 x 14 1/2 DVC Wilson Snyder pump operating at 3,000 gpm. The hearth stave pump supplied cooling water to the hearth staves and the cinder notch of Dorothy Six. Stack motor/pump assembly number one consists of a 100 hp, 1770 rpm General Electric Induction motor connected to a 8 x 6 Type SH Allis-Chalmers pump operating at 1500 gpm. Stack motor/pump assembly number two consists of a 100 hp, 1775 Westinghouse motor connected to a 8 x 6 Type SH Allis-Chalmers pump operating at 1500 gpm. The strainers include two Type AL 16" Elliott Twin Strainers, one 16" Hellan automatic self-cleaning strainer, and one 24" Type 7 Elliott self-cleaning strainer. Service water drawn from the Monongahela River is passed through the strainers in order to clean it of debris before it is passed into the pump suction connections.

Construction of pump house: 1961.
Installation of strainers and motor/pump assemblies: 1961.

H. Strainer Pits and Strainers at Blast Furnaces Number One and Three: Abutting the center west inside wall of cast houses numbers one and three is a 4'-7 1/2" wide x 29'-3" long x 9'-10" deep strainer pit. Three Type AL 14" Elliott Twin Strainers and associated water piping are located approximately 2'-0" above the pit along the inside wall. The strainers perform the same function as described in I - G.

Installation of strainers at both furnaces: 1961.

I. Cooling Water Circle Pipes, Cooling Plates, Waste Water Troughs, Cinder Notch, and Tuyere Coolers at Blast Furnace Numbers One and Three: Encircling each furnace bosh is a 10" diameter pipe which supplied cooling water taken from the bosh pump discharge connection to the bosh and hearth area. Encircling each furnace stack is a 6" diameter pipe which supplied cooling water taken from the stack pump discharge connection to the stack. At the hearth and bosh area the cooling water was delivered to copper cooling plates. The approximately 6" wide x 1'-0" long x 1'-0" deep hollowed out cooling plates are inserted into furnace shell openings all around its circumference. The cooling plates are connected in series by flexible hoses running from the 10" diameter circle pipe. Copper cooling plates inserted into shell openings around the circumference of each stack are arranged, relative to the 6" diameter circle pipe, in the same manner as the hearth and bosh system. A rectangular trough which encircles the bosh above the 10" diameter circle pipe collected the waste water after it had passed through the cooling plates. The waste water passed from the trough to two 10" diameter pipe lines leading to a sewer. A rectangular trough encircling the stack above the 6" diameter circle pipe performed the same function before passing the waste water to two 6" diameter pipes leading to the sewer. Coolers which are fit inside of each furnace's cinder notch and tuyeres were supplied by a 2" diameter high pressure water line running from the main plant pump house.

Installation of cooling water facilities at blast furnace number one: 1973.
Installation of cooling water facilities at blast furnace number three: 1971.

II. Blast Furnaces:

A. Blast Furnace Number One: The centerline of blast furnace number one is located 52'-0" east of the eastern wall of the stockhouse and 117'-6" south of the northern edge of the ore yard. The height of the furnace is 99'-1" from the bottom of the hearth to the top of the stack. The diameter of the hearth is 20'-0". The distance between the hearth line and the bosh line is 10'-3". The furnace sits on a 26'-0" diameter x 10'-6" deep ceramic bottom block, the top of which is located 4'-3" below the floor line of the cast house. The furnace has a working volume of 25,821 cubic feet. Encircling the furnace's hearth are twelve equally spaced 18" diameter tuyere openings. The tuyere openings are located 9'-9" above the bottom of the hearth. The iron notch is located on the eastern side of the furnace, 2'-9" above the bottom of the hearth. The slag notch or "monkey" is located 90 degrees from the iron notch on the northern side of the furnace, 6'-7" above the hearth bottom. The furnace shell is 7/8" thick. The 3'-0" thick lining between the furnace shell and the circumference of the hearth is made up of carbon brick manufactured by the National Carbon Company. The furnace bosh and stack is lined with several courses of fire brick manufactured by the American Fire Clay Company.

Original construction date: 1896.
Last furnace relining: 1973.
Retired: 1982.

B. Remains of Blast Furnace Number Two: The remains of blast furnace number two are located 293'-3" directly south of blast furnace number one. The remains consist of the hearth portion of the furnace shell and the concrete pad upon which it sits.

Original construction date: 1896.

C. Blast Furnace Number Three: Blast furnace number three is located 238'-9" south of blast furnace number two. The height of the furnace is 101'-0 1/2" from the bottom of the hearth to the top of the stack. The hearth diameter is 23'-0". The distance between the hearth line and the bosh line is 11'-8 1/2". The furnace sits on a 29'-0" diameter x 12'-2" deep ceramic bottom block. It has a working volume of 32,542 cubic feet. Sixteen equally spaced 18" diameter tuyere openings encircle the furnace's hearth. The tuyere openings are located 10'-2 1/2" above the bottom of the hearth. The iron notch is located on the eastern side of the furnace, 3'-1 1/2" above the bottom of the hearth. The "monkey" is located 90 degrees from the iron notch on the northern side of the furnace, 7'-6 1/2" above the bottom of the hearth. The furnace shell is 7/8" thick. The carbon brick lining between the furnace shell and the circumference of the hearth is 3'-0" thick. The furnace bosh and stack is lined with several courses of fire brick.

Original construction date: 1896.
Last relining: 1971.
Retired: 1982.

D. <u>Remains of Blast Furnace Number Four</u>: The shell of blast furnace number four is located 293'-0" south of blast furnace number three. The height of the furnace is 100'-0" from the bottom of the hearth to the top of the stack. The diameter of the hearth is 24'-6". The furnace sits on a 30'-6" diameter x 10'-6" deep ceramic bottom block. It had a working volume of 35,215 cubic feet. Sixteen equally spaced 18" diameter tuyere openings encircle the furnace's hearth. The tuyere openings are located 9'-8" above the bottom of the hearth. The iron notch opening is located on the eastern side of the furnace, 2'-8" above the bottom of the hearth. The "monkey" is located 90 degrees from the iron notch on the southern side of the furnace, 6'-6" above the bottom of the hearth. The furnace shell is 7/8" thick.

Original construction date: 1896.
Last relining: 1969.
Retired: 1979.

III. <u>Cast Houses</u>:

A. <u>Cast House Number One</u>: Laid out on an east-west axis, cast house number one is built around blast furnace number one. It is 70'-0" wide x 108'-0" long x 30'-0" high to the bottom chord of the truss. The concrete foundation of the building supports a steel framework which is encased by brick walls. The building's louvered 1/4" thick steel plate gable roof is supported by four equally spaced riveted Pratt trusses running in a north-south direction which sit on top of two equally spaced Warren trusses running in a east-west direction. An approximately 20'-0" high x 20'-2 1/2" wide craneway, running in a north-south direction extends from the eastern wall of the building. Constructed off the southern inside wall of the cast house is an approximately 8'-0" wide x 30'-0" long x 10'-0" high control room. The center of the furnace is located 35'-0" from the building's northern wall and 31'-0" from its western wall.

The casing and motor for the clay gun, manufactured by the Bailey Company, and the Woodings Industrial Corporation air drill are laid out linearly on a north-south axis at the eastern side of the furnace. Resting on the craneway east of the mud gun and air drill is a Sheppard/Niles 10-ton crane. The control room contains a snort wheel, a signal box from blow engine house number two, and various switches and gauges pertaining to the cooling water system, hot blast temperature and hot blast pressure. A manually operated lever and pulley system leading upwards to the bleeder stacks at the top of the furnace is located in each corner of the cast house.

Leading from the iron notch on the eastern side of the furnace are the remains of the iron runners, which consist only of the slightly sloped 4'-6 1/2" wide x 2'-0" deep x 22'-9" long iron trough. Two slag runners extend from the "monkey" at the northern side of the furnace. One runner travels in a northerly direction, the other in a northeasterly direction. Each runner emptied out into one of the slag pit's two sections. Approximately 20'-0" below the cast house floor on its eastern side are the standard gauge railroad tracks where two "submarine" ladle cars were spotted in order to receive molten iron while the furnace was tapped.

Original construction date: 1896.
Rebuilt: 1924.
Construction of iron and slag runners: 1969.
Installation of crane: 1924.
Installation of clay gun and air drill: 1962.

B. Remains of Cast House Number Two: The remains of cast house number two consist of its brick walls surrounding the remains of blast furnace number two.

Original construction date: 1896.
Rebuilt: 1924.

C. Cast House Number Three: Built around blast furnace number three, cast house number three is laid out on a east-west axis. It is 70'-0" wide x 103'-0" long x 30'-0" high to the bottom chord of the truss. A steel framework encased by the brick walls is supported by the building's concrete foundation. Four equally spaced riveted cambered fink trusses running in a north-south direction support the building's louvered 1/4" thick steel plate gable roof. Extending from the eastern wall of the building is an approximately 20'-0" high x 30'-0" wide craneway running in an north-south direction. Constructed off the southern inside wall of the building is an approximately 8'-0" wide x 30'-0" long x

10'-0" high control room. The center of the furnace is located 35'-0" from the building's northern wall and 33'-0" from the its western wall.

Laid out linearly on a north-south axis on the eastern side of the furnace is a clay gun, manufactured by the William Bailey Company of Pittsburgh, PA, and an air drill, manufactured by the Woodings Industrial Corporation of Mars, PA. A Sheppard/Niles 10-ton crane rests on the cast house craneway. The control room contains a snort wheel, control switches for the furnace tuyeres, a signal box from blow engine house number two, and gauges pertaining to the cooling water system, hot blast temperature and hot blast pressure. Located at each corner of the cast house is a manually operated lever and pulley system which is connected to the bleeder stacks at the top of the furnace.

The cast house's iron runners extend from the iron notch on the eastern side of the furnace. They consist of an approximately 4'-6" wide x 2'-0" deep x 23'-3 1/2" long slightly sloped iron trough which leads to a series of 2'-9" wide x 1'-6" deep slightly sloped iron runners travelling eastward. Located approximately 15'-0" below the terminus of the cast house iron runners along the eastern side of the building is a set of standard gauge railroad tracks where "submarine" ladle cars were spotted in order to receive the molten iron while the furnace was being tapped. A series of 2'-8 1/2" wide x 1'-7" deep slightly sloped slag runners extend from the "monkey" at the northern side of the furnace. Travelling in a north by northeast direction, the slag runners emptied out into 400 cubic foot capacity slag ladles which were located on rail cars set upon standard gauge tracks approximately 20'-0" below the northern end cast house floor.

Original construction date: 1896.
Rebuilt: 1920.
Construction of iron and slag runners: 1970.
Installation of crane: 1924.
Installation of clay gun and air drill: 1962.

D. Remains of Cast House Number Four: Laid out on a east-west axis, the remains of a cast house number four consist of its brick walls, floor, control room, and partial steel framing surrounding the remains of blast furnace number four. Supported by a concrete foundation, the 70'-0" wide x 78'-3" wide x 30'-0" high remains encase the building's steel frame. The approximately 8'-0" wide x 30'-0" long control room is located along the inside northern wall of the cast house remains. Also extending from the inside northern wall is an approximately 20'-0" high x 30'-0" wide craneway running in a east-west direction. The center of the furnace remains is located 35'-0" from the northern wall and 27'-0" from the western wall.

Located inside the control room is the snort wheel and a number of unidentifiable gauges, switches and charts. A 10-ton Sheppard/Niles crane sits on the cast house craneway.

The remnants of the slag runners lead to a slag pit located at the southern end of the building. Located below the eastern end of the cast house is a set of standard gauge tracks which transported "submarine" ladle cars.
Original construction date: 1896.
Rebuilt: 1918.
Installation of crane: 1924.

IV. Slag Pits:

A. Slag Pit Number One: The slag pit for blast furnace number one is adjacent to the northern side of the cast house. Laid out on a east-west axis, the pit is broken up into two approximately 12'-0" deep sections. The section closest to the cast house has a capacity of 58,100 cubic feet. The other section has a capacity of 66,500 cubic feet. Running along the sides of the slag pit are several 6" diameter water pipes which are equipped with spray connections for spraying the slag after it had been deposited into the pit. The water was supplied to the connections at a rate of 500 gpm from a 50,000 gallon holding tank which is located behind the eastern wall of the cast house. The holding tank received its contents from a 6" diameter blow-down line leading from the cold well at the evaporative waste water recycle system.
Construction of slag pit: 1953.
Installation of holding tank: 1979.

B. Slag Pit Number Four: The 29'-3" wide x 50'-0" long x 22'-0" deep slag pit for blast furnace number four is laid out on a north-south axis adjacent to the south end of cast house four. A 10'-0" high brick wall rims the pit. Several equally spaced water spray nozzles are located on the brick walls. The spray nozzles utilized water drawn from the plant's service water system in order to granulate the slag as it entered the pit. A 31'-4" wide craneway is located directly over the pit. Sitting on top of it is a 15-ton Alliance crane.
Construction of slag pit and craneway: 1909.
Installation of crane: 1958.

V. Ladle Preparation Facilities:

A. New Ladle House: Located approximately 30'-0" south of clarifier number one, the new ladle house is laid out on a northeast-southwest axis. It is 75'-0" wide x 186'-0" long x 61'-9 1/2" high to the bottom chord of the truss. The building's concrete foundation supports a steel framework. Riveted Fink trusses support the building's roof and monitor. It has a corrugated metal exterior. Spanning the width of the building and running its entire length is a 51'-0" high craneway. A 25-ton crane rests on the craneway. Separate sets of standard gauge railroad tracks run through the length of the building on its eastern and western end.

An approximately 20'-0" wide x 40'-0" long x 15'-0" high concrete block building with gable roof is located inside of the new ladle house at its southern end. The building contains facilities for clay storage, a clay mixer, and an oven. The controls for the oven were manufactured by the Honeywell Corporation.
Original construction date: 1908.
Construction of 50'-0" extension to northern end: 1950.

B. Car Repair Shop (Old Ladle House): The car repair shop is located along the shoreline of the Monongahela River, approximately 150'-0" east of blow engine house number two. It is 61'-0" wide x 132'-0" long x 35'-1 1/2" high to the bottom chord of the truss. Constructed from a concrete foundation, the building's brick walls encase its steel framework. Two rows of segmented arch windows rim the south facade and southern one-third of the eastern and western facade of the building. Located at the eastern end of the south facade is an approximately 18'-0" wide x 33'-8" high opening which provides the entrance for two parallel sets of standard gauge railroad tracks. A 25'-0" high craneway spanning the inside width of the building has a 25-ton crane resting on top of it. Fink trusses support the building's gable roof and louvered monitor.

Located along the western inside wall of the building is an acetylene welding area and office space. A ferromanganese casting car is located on the eastern set of tracks inside of the building.
Original construction date: 1896.
Construction of 33'-0" extension to southern end: 1920.

C. Ferromanganese Car Preparation Building (Former Scrap Preparation Building): The ferromanganese car preparation building is located at the extreme south end of the upper works. Laid out on a north-south axis, it is 63'-4 1/2" wide x 500'-0" long x 43'-0" high to the bottom chord of the truss. The building's steel frame and corrugated metal exterior is supported by a concrete foundation. Its gable roof is supported by riveted Fink trusses. A 34'-4" high craneway spans the width of the building and runs its entire length. A 10-ton crane rests on the craneway. A standard gauge railroad track, located 26'-3 1/2" off the western wall, runs through the length of the building. Located 17'-7" from the western wall and beginning 47'-8 1/4" from the northern wall is a 3'-0" wide x 280'-0" long x 6'-2" high steel framed service platform for preparing ferromanganese casting cars.

Laying about the floor throughout the building are electrical motors, drying hoods, and other sorts of mill equipment.
Construction date: 1932.
Construction of service platform: 1962.

VI. Refractory Brick Storage Facilities:

A. Brick Shed Number One: Laid out on a north-south axis, brick shed number one is located approximately 150'-0" northeast of the ferromanganese car preparation building. The wood framed building is 50'-0" wide x 400'-0" long x 16'-0" high to the bottom chord of the truss. Pratt trusses support the building's gable roof and five rectangular box monitors. The wooden trusses have 1 1/4" vertical steel tie rods. Corrugated metal sheeting on the roof and sides of the building makes up its exterior. An approximately 10'-0" wide x 10'-0" high entrance exists in the middle of the north and south walls of the building.

Located within the building are several pallets containing refractory bricks. The bricks were stored for later use in the relining of iron and cinder ladles, ferromanganese casting cars, the blast furnaces and the hot blast stoves.
Construction date: 1910.

B. Brick Shed Number Three: Brick shed number three is laid out on a north-south axis and is located approximately 50'-0" northeast of brick shed number one. The wood framed building is 50'-0" wide x 350'-0" long x 16'-0" high to the bottom chord of the truss. Wooden Pratt trusses with 1 1/4" vertical steel tie rods support the building's gable roof. The building's exterior is made up of corrugated metal sheeting on its roof and sides. An approximately 10'-0" wide x 10'-0" high entrance exists in the middle of its northern wall. The southern wall of the building has been knocked down.

The interior of the building contains several pallets of refractory bricks. The bricks were used for the same purpose as those stored in brick shed number one.
Original construction date: 1910.
Construction of 80'-0" southern extension: 1918.

VII. Iron Purification and Delivery Facilities:

A. Calcium Carbide Silo and Dispensers: The 220-ton calcium carbide silo sits on a concrete pad located near the shoreline of the Monongahela River, just east of the iron de-sulfurization building. Located directly below the 20'-0" diameter x 35'-0" high silo are two 4'-6" diameter x 12'-0" high dispenser tanks which are connected to it by means of a 8" diameter pipeline. A 2" diameter pipeline leads from the 3.3-ton dispensers to a flexible connection at the lance car assemblies on the second floor of the iron desulfurization building. The silo and dispenser arrangement was designed and manufactured by Canadian Met-Chem Consultants, Limited of Montreal, Quebec.
Installation date: 1980.

B. Iron Desulfurization Building: The iron desulfurization building is located between the calcium carbide silo and the new ladle house. Built by the American Bridge Company, the two story building is 32'-0" wide x 112'-0" long x 49'-3" to the bottom chord of the craneway. A 2-ton service crane rests on the craneway. A concrete foundation supports the building's steel framework. Its slightly gabled roof is supported by wide-flange I-beams. The exterior of the building is made up of corrugated metal sheeting on its roof and sides. Four ventilation ducts protrude up through the roof. A 17'-0" wide x 17'-2" high opening exists at both ends of the building. Running through the openings is a standard gauge railroad track from which 175-ton "submarine" ladle cars entered and exited the building by means of a Stephens-Adamson car puller located outside of its eastern wall.

A fume hood, located near each end of the building, protrudes downwards through the first floor ceiling. Each hood is connected to a 38" diameter duct which rises up the western inside wall of the second story before exiting through the wall into a bag house which is attached to the outside western wall at an inlet elevation of 21'-0" above grade. The bag house consists of three dust collectors connected at their bottom openings by a screw conveyor leading to a swivel chute. A 4'-6" diameter x 70'-0" high stack is located just outside the building's western wall at its northern end. A lance transfer car complete with its lance is located near each end of the building on the second floor. Each transfer car sits upon a standard gauge track which is positioned directly above the track on the first floor. Their lances are connected to 2" diameter pipe leading from the calcium carbide dispenser by a flexible connection. An approximately 8'-0" wide x 25'-0" long x 10'-0" high control room sits directly on top of an electrical room of the same size along the inside western wall of the second floor. All equipment within the

building was designed and manufactured by Canadian Met-Chem Consultants Limited of Montreal, Quebec.
Construction date: 1980.

C. Hot Metal Track: The track running through the iron desulfurization building becomes a hot metal track leading to the basic oxygen steelmaking shop after it leaves the building.
Installation date: 1980.

VIII. Ferromanganese Preparation, Storage, and Delivery Facilities:

A. Primary Ferromanganese Crushing and Conveying Line: Travelling in a west to east direction, the primary ferromanganese crushing and conveying line is located 270'-0" north of the ferromanganese car preparation building. The line consists of a 7'-0" high steel framed platform straddling a standard gauge railroad track at its far western end; a motor driven 36" x 15'-3" Pioneer Oro Feeder leading to a 24" x 36" Pioneer Jaw Crusher driven by a 150 hp motor capable of crushing 125 tons per hour; and a 30" x 46'-0" motor driven conveyor belt extending from just below the jaw crusher and rising at a slope of 10 degrees.
Installation date: 1965.

B. Secondary Ferromanganese Crushing and Conveying Line: The secondary ferromanganese crushing and conveying line is laid out parallel to and 19'-0" south of the primary line. It consists of a 7'-0" high steel framed platform straddling a standard gauge railroad track at its far western end; a 25 hp motor driven 36" x 12'-3" Pioneer Oro Feeder leading to a 125 ton per hour 150 hp motor driven 24" x 36" Pioneer Jaw Crusher; and a steel framed 30" x 50'-0" motor driven conveyor belt extending from just below the conveyor belt and rising at a slope of 10 degrees.
Installation date: 1955.

C. Crushing and Screening Control House: An approximately 8'-0" square x 8'-0" high corrugated metal control house sits on a raised platform between the primary and secondary crusher.
Construction date: 1965.

D. Ferromanganese Conveying, Screening, Storage, and Delivery Line: The 250'-0" long ferromanganese conveying, screening, and storage line is laid out perpendicular to the primary and secondary lines at their eastern end and travels southward to within 20'-0" of the ferromanganese car preparation building's north wall. It consists of a steel framed 30" x 250'-0" motor driven conveyor belt extending from below the primary and secondary line which rises at a slope of 10 degrees; a three grid shaker screen, located below the high point of the conveyor on a steel platform; three chutes which connect the screen to three 150-ton storage bins which are hung from the platform; and a ramp from which trucks received ferromanganese by means of a Syntron vibrating feeder leading from the bottom of each storage bin.

Installation date: 1955.

E. Trade Ferromanganese Storage and Shipping Building: The trade ferromanganese storage and shipping building is built off the eastern wall of the ferromanganese car preparation building, 200'-0" from its southern end. The one story steel framed building with a sloped roof is 60'-0" wide x 140'-0" long. It has a corrugated metal exterior. Located inside of the building are eleven 20'-0" square x 8'-0" high wooden storage bins located along its eastern and western walls. A 12'-0" wide x 72'-0" long loading dock extends from the southern end of the building along its outside eastern wall. A 12'-0" wide x 20'-0" long office enclosure is adjacent to the northern end of the loading dock. Running alongside of the loading dock is a standard gauge railroad track.

Construction date: 1966.

F. Hopper Rail Car and Truck Scale: A 100-ton rail car and truck scale is located approximately 200'-0" northeast of the storage hoppers. A 10'-0" wide x 24'-0" long x 10'-0" high concrete block recording house is located next to the scale on its western side.

Installation and construction date: 1955.

HISTORY

The basic steps involved in the production and delivery of pig iron at the blast furnace remained essentially the same at the Duquesne Works, as in all integrated steel mills, throughout its history. In the general practice, iron ore, coke, and limestone (or some other fluxing agent like dolomite) was charged into the top of the furnace at a weight ratio of approximately 2:1:1/2 respectively. After the raw materials entered the top of the furnace they came in contact with an ascending current of hot gases. The first change that took place was one of drying, as the moisture within the raw materials was driven off by the gases and carried out of the top of the furnace. Subsequently, the stock filled with a gaseous atmosphere containing the reducing agent carbon monoxide, and began its descent toward the higher temperatures at the bottom of the furnace. During the descent, carbon monoxide, which was produced by the contact of coke with the hot blast air at the level of the tuyeres, reduced the ore to free iron in a spongy state by oxidation and liquified the limestone. At the top of the bosh, or fusion zone of the furnace, lime combined with the minerals which had been separated from the ore such as silica, aluminum, and part of the manganese to form slag. From this point the slag and the liquified iron trickled down through the interstices of the coke at the combustion zone of the furnace to the hearth. Both substances attracted the sulphur and ash of the coke to them during their downward flow. Due to its lighter weight, the slag formed a molten layer on top of the iron. As the hearth continued to fill, the slag, because of its chemical composition, attracted part of the sulphur in the molten iron to it.

After an interval of several hours, the hearth became full and the furnace was ready to be tapped. Iron was taken from the furnace through a tap hole called the iron notch. Located on the furnace at the level of the cast house floor, the iron notch was opened by means of an pneumatic air drill. Upon opening, molten iron, at a temperature of approximately 2600 degrees F., rushed out of the furnace into a series of clay runners embedded in the cast house floor before making its way to sand molds located on the floor or to waiting ladle cars which were located on standard gauge tracks below the cast house at the end of the runners. After 1898, molten iron flowed exclusively to the ladle cars. Shortly after the iron had been tapped, the slag was withdrawn from the furnace through the slag notch or "monkey." Located 90 degrees from the iron notch on the furnace at a slightly higher elevation, the "monkey," which was opened by removing a short iron rod called the bott, allowed the slag to flow from the furnace into a series of clay runners also embedded in the cast house floor. The runners led to either a slag pit, or to waiting cinder pot rail cars, either of which were located below and outside of the cast house. After tapping, the iron notch was plugged up by means of a mechanical clay gun and the bott was reinserted in the "monkey."

Ladle cars filled with molten iron were either taken to a pig casting machine (after 1898) where it was cast into molds to be sold on the merchant iron market or to the steelmaking plant where it was converted into steel by a number of different steelmaking processes -- including the Bessemer, open hearth, or basic oxygen processes. In either case, the iron had to be desulphurized because the presence of too much sulphur in merchant iron caused excessive shrinkage in castings and because its presence in steel caused cracking across the ingot surface during rolling. Historically, desulphurization took place internally within the Bessemer converter or open hearth furnace itself or externally by adding soda ash or calcium carbide to the ladle so as to create a slag which could attract the remaining sulphur to it.[1]

Although the basic steps involved in the production and delivery of pig iron at the Duquesne Works remained basically the same throughout its history, the equipment which carried out those steps changed significantly over time. At its inception in 1896, the four furnace plant was utilized not only for purposes of iron production but also played a role in the research and development of new practices.

One such test involved dramatically increasing the number of tuyeres per furnace. Each of the new furnaces, which were laid out linearly on a north-south axis, was 100'-0" high with a hearth diameter of 14'-0" and a bosh diameter of 22'-0". Blast furnace numbers one and two (the first two put into blast) each had ten 7" diameter tuyeres, while numbers three and four were equipped with twenty 5" diameter tuyeres. By increasing the number of tuyeres at the latter furnaces, plant engineers hoped that the concomitant increase in the area of combustion would result in higher furnace productivity. Another point in favor of dramatically increasing the number of furnace tuyeres, the engineers argued, was that the dead space between adjoining tuyeres would be reduced, thus limiting the accumulation of chilled stock. Chilled stock contracted the effective tuyere area over time, thereby causing slips and irregularities in the furnace.

Although the new blast furnace plant immediately set a world standard for productivity of comparable size plants, the performance of blast furnace number one, which consistently led the way, belied the argument favoring a dramatic increase in the number of tuyeres per furnace. By the end of 1896, for example, a world wide production record of 572.7 tons per day was set at blast furnace number one. Ten years later, in March of 1906, moreover, with the plant continuing to lead the way in terms of productivity by maintaining an average of 630 tons per day per furnace, blast furnace number one averaged 760 tons per day. The dramatic overall increase in productivity at the Duquesne plant, then, must be attributed to its unique automatic raw materials delivery system rather than to any increase in the number of tuyeres per furnace.[2]

Notable among other features of the new plant's iron production and delivery system at the blast furnaces was its casting facilities. Built around each furnace was a one story, 70'-0" wide x 219'-0" long cast house, laid out on a east-west axis. A narrow track, suspended from the roof trusses along the center of each cast house, supported a 5-ton hoist which was used to facilitate the return of cast house scrap to the furnace. Located on each side of the hoist was a 10-ton overhead electric crane which ran the length of the cast house. The cranes were used to handle the molds for making pig beds on the cast house floor and for carrying the 26'-0" long pigs to the end of the building where a series of motor driven rollers conveyed them to a mechanical pig breaker. The pig breaker, which in itself represented a vast improvement over the common and extremely arduous method employed at the time of breaking and carrying the pigs by hand, was quickly supplanted by the Uehling pig casting machine. Under the new system, molten iron was run from the furnace directly into ladle cars and transported to the pig caster which was located along the shoreline of the Monongahela River near the southern end of the plant. First introduced at Duquesne, the machine consisted of an endless chain which carried molds into which the molten iron was poured. The molds were cooled by immersion in water and the solidified iron dropped from them into a waiting railroad car. Before each cast the molds were coated with lime to keep the iron from sticking. About 25 percent of the iron produced during the early years of the plant's operation were cast in this way.

The remaining iron was tapped directly into 25-ton ladle cars. Preparation of the ladles prior to tapping took place in an existing ladle house which was built in 1886 to prepare ladles used at the Bessemer converter plant. From the cast house the ladle cars were taken directly for use in the Bessemer plant or after 1902, the open hearth furnace plant where internal desulphurization took place.[3]

Two new furnaces, numbers five and six, and a new ladle house were added in 1909. The furnaces were laid out linearly along the same line as the original four. Each furnace was 94'-0" high with a hearth diameter of 17'-0" and a bosh diameter of 22'-0". The casting facilities for both furnaces were located in a one story, 310'-0" long x 60'-7 3/4" wide building which adjoined the two furnaces. The new ladle house replaced the original ladle house which became a car repair shop for the work's rolling stock (ladle cars, cinder pot cars, and raw material transfer cars). In addition a new pouring building was built by the American Bridge Company just south of the new ladle house. The one story, 26'-0" wide x 119'-6" long steel framed corrugated metal building housed four new double strand Heyl and Patterson pig casting machines of the Uehling type.

During the major reconstruction of the blast furnace plant between 1918 and 1924 the cast houses at furnace numbers one through four were rebuilt because the presence of the pig casting machines made it unnecessary to cast molds inside of the buildings. Consequently, the length of each cast house was decreased by over one-hundred feet and the cranes serving the old pig breaker were removed. Each of the blast furnaces, save number six, were also rebuilt during this period. Conforming to new ideas about the relationship between productive capacity and the design of furnace lines, the rebuild resulted in furnaces with larger hearth diameters (17'-0" for all rebuilt furnaces but number two which was 18'-0") and shorter bosh heights. When, however, it was found that the furnace rebuilding project increased annual capacity for the entire plant by only 6,600 tons over the pre-reconstruction figure of 1,035,000 tons, each of the six furnaces were relined in 1928 and 1929. The relining, which slightly increased the bosh diameter of each furnace, expanded annual capacity to 1,319,200 tons.[4]

Although furnace linings normally wore out every four or five years, the slack demand for iron and steel products during the depression years meant that the furnaces were hardly in use until the first half of the 1940s. Consequently, no further additions or modifications were made to the iron production and delivery facilities until after World War II when all of the furnaces were relined and ferromanganese was added to the plant's product mix at blast furnace number two in 1949. The relining resulted in larger hearth diameters for each furnace, thereby increasing annual plant capacity to 1,451,400 tons, of which 105,200 tons were devoted to the production of ferromanganese.

The steps involved in the production and delivery of ferromanganese necessitated significant changes to the blast furnace plant between 1949 and 1956. In the process of making these changes, many of which began as on site improvisations seeking ways to upgrade old methods, the Duquesne Works became the most modern ferromanganese production and delivery facility of the time.

A common alloy of steel, ferromanganese was produced by charging four parts manganese ore to one part iron ore into the top of the blast furnace along with coke and limestone. Moreover, because of the high melting point of the manganese ore, the production of ferromanganese required twice as much coke as the production of basic iron which, in turn, considerably increased temperatures inside of the furnace. As a result, it was normal practice to put a furnace on ferromanganese production during the last year of its scheduled campaign (i.e. when its lining was about ready to give out). When the decision to produce ferromanganese at Duquesne was made, however, it was decided to abandon normal practice by adding special features to the furnaces used for this purpose. Consequently, blast furnace number two, and, in 1953, blast furnace number three, were fitted with nine extra rows of cooling plates and new water sprays inside the furnace before they were put on "ferro".

The process by which ferromanganese was delivered also substantially upgraded industry-wide practice albeit in a more gradual manner during this period. Initially the molten product was tapped from the furnace in the same way as basic iron. After tapping, the 35-ton ferromanganese ladle cars were run over to the pig casting machine where they were cast in the normal manner. The brittle nature of the solidified product, however, caused the pigs to break up as they dropped from the mold chain. Consequently, there was a considerable loss in "fines" or small pieces of the product chipped from the pigs. In an effort to offset this loss, plant officials, emulating the practice used at the Clairton and Isabella blast furnace plants, switched in January of 1954 to the car casting technique. The former open hearth scrap preparation building, located at the extreme southern end of the plant, was converted into a car preparation facility so that the 9'-6" wide x 41'-0" long x 2'-0" deep refractory brick lined cars could be prepared for casting by applying a protective slurry to its deck and side plates. At first the slurry was applied by hand using the bucket and broom technique, a process which took one hour to complete. This time was cut to five minutes when application of the slurry by air hose was introduced shortly thereafter.

In order to tap molten ferromanganese from the furnace into the casting cars, special cast iron runners had to be fabricated for use in the cast house. Unlike 35 ton ladles, which were 9'-1" deep, the casting cars were quite shallow. Moreover, the molten material was cast only 8" deep across the length of the car. Consequently, the special runners were hung from the end of each cast house runner at a 45° angle to a point 1"-0" above the casting car so as to prevent the molten material from splashing over its sides. Once tapped, the cars were run over to the car preparation building where the product was allowed to cool. Initially allowed to cool in contact with the air, the practice was later changed when a multi-jet spray water unit was installed to continuously quench the product. As a result, the elapsed time from casting to unloading was reduced from sixty hours to thirty hours without harming the physical properties of the material.

The casting cars were initially unloaded by methods which had been practiced for many years throughout the industry. Men wielding twenty-two pound sledge hammers and crow bars attacked the solidified product until it was broken up to a point where chunks of it could be unloaded by hand or by overhead crane to a storage pile. The arduous, hazardous, and time consuming nature of this approach prompted efforts to experiment with different forms of unloading. A solution was found when a mobile excavator was rented to explore the possibility of mechanical unloading.

Although immediately successful, men were still required to dig a starting point from which the machine unloader could work until, through a bit of improvisation, a quarter section of a scrap ingot mold was placed in one end of each car just before casting. Removal of the section after solidification provided the necessary starting point for the unloader. The addition of a make-shift raised platform supported by scrap ingot molds and straddling the casting car unloading track refined the operation because it allowed the excavator to unload directly into trucks or rail cars for shipment on one side of the platform or to a stockpile on the other side. Eventually a permanent raised platform was constructed in conjunction with the installation of a new crushing, screening, and storage system in 1955.

The new system, which capped the modernization of the plant's ferromanganese facilities, was the result of an extensive study to identify consumer needs taken on by the company after it was decided to centralize production at Duquesne. Determination of a product size suitable for furnace and ladle additions at consumer facilities was of particular interest. To this end, it was decided to install a crushing, screening, and storage system which was interlocked by two sloped conveyors, 50 and 250 feet in length respectively. Laid out in the shape of an L, the process began at ground level with the excavator feeding the large chunks of "ferro" from the casting car to a crusher capable of processing 125 tons per hour. After crushing, the material was conveyed to an elevated screening station where it was separated by size as it passed over three grids of a shaker screen. Depending upon its size, the material was dropped through a duct to one of three 150-ton storage bins, each of which was equipped with a retractable chute for gravity loading onto railroad cars or trucks. In 1965 a parallel crusher and conveyor was added to the system along with a ground level storage building constructed off the side of the car preparation building.[5]

During the late 1950s and early 1960s significant changes were made to the plant's iron production and delivery facilities beginning with the dismantling of blast furnaces numbers five and six and their replacement by Dorothy Six. Possessing a working volume (49,568 cu. ft.) which surpassed the combined working volume of the two furnaces (49,540 cu. ft.) it replaced, the 108'-0" high x 28'-0" hearth diameter furnace also exhibited notable recording features and casting facilities. A total of ten probes were placed in an horizontal position at three different heights along the furnace stack in order to give furnace operators information about the composition of gases and temperatures throughout the furnace. The power driven probes burrowed their way to the middle of the burden before they were withdrawn. As the probes exited the furnace, they were stopped at predetermined intervals to make recordings. A 70'-0" long eleventh probe, equipped with eight thermocouples, was inserted permanently into the burden vertically from the furnace top. The data which these probes provided was expected not only to lead to improved production but also to give engineers vital information concerning future blast furnace design.

An exceptional feature of Dorothy's casting facilities was its two tap holes or iron notches. Located at a 90 degree angle from each other, the tap holes emptied into two sets of parallel iron runners, each of which fed four 175-ton "submarine" ladle cars. The ladle cars were run into the one story, 80'-0" wide x 250'-0" long cast house on four parallel hot metal tracks located on each side of the iron runners. One runner, then, served two hot metal tracks. As such, the relationship between the casting facilities inside of the cast house and the furnace's two tap holes significantly shortened the delivery time of the molten iron to the work's steelmaking plant.[6]

The plant's iron and ferromanganese production and delivery system changed significantly between the late 1960s and 1980 because of events within the plant, corporate reorganization policies, and an investment in advanced desulphurization technology. The production of ferromanganese at Duquesne, for example, received a mortal blow when a breakout of the molten material destroyed blast furnace number two in the late 1960s. The most consistent producer of ferromanganese in the plant, the furnace was eventually torn down in the mid-1970s.

Coming on the heels of the accident, corporate officials decided to merge the National Works in McKeesport with the Duquesne Works in 1969. Based on the more modern iron and steel making facilities on the Duquesne site, the move required that the National Works shut down its own iron and steelmaking operations while drawing upon Duquesne for all its semi-finished steel needs. As a result of its increased iron making responsibilities, all of the Duquesne furnaces were put on iron production. Additionally, the working volume of blast furnace number four (from 31,504 to 35,215 cu. ft.) was upgraded as was Dorothy Six's (to 58,045 cu. ft.). All ferromanganese operations, moreover, were shifted to the McKeesport site.

The decision to build a modern desulphurization facility in 1980 on blast furnace plant grounds was taken to increase the efficiency of Duquesne's basic oxygen steelmaking furnaces. With the advent of basic oxygen steelmaking, iron desulphurization was performed externally by blowing calcium carbide through a lance into the molten bath and skimming off the resulting slag before the iron was charged into the oxygen furnace. At Duquesne, the process originally took place at the BOP shop where the contents of "submarine" ladle cars from the blast furnaces were reladled into open top ladles before the iron was manually desulphurized. The time taken to desulphurize the iron in this manner resulted in a significant drop in the temperature of the molten bath, thereby increasing the oxygen blowing time at the furnace. Under the new system, the "submarine" cars were taken directly from the cast house to the desulphurization building where they were spotted under one of the facility's two fume hoods. A lance transfer car, riding on rails on the second floor of the building, was positioned at the fume hood where its lance was inserted down through a hood opening into the top opening of the "submarine" car. Calcium carbide was then drawn from a 220-ton silo located next to the building and blown through the bath. The resulting fumes from the blow were directed through the hood to a bag house attached to the western wall of the building where the particulate was filtered out before the gasses were exhausted to the atmosphere through a nearby stack. After the process was complete, the resulting slag was skimmed off the bath and "submarine" cars were taken to the BOP shop. Because the "submarine" ladles also acted as mixers, the temperature of the bath remained constant. Consequently, the blowing period at the oxygen furnace was decreased.[7]

<u>ENDNOTES</u>:

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2."The Duquesne Furnace Plant of the Carnegie Steel Company Limited," <u>The Iron Age</u> 59 (March 25, 1897): 8, 9; "The Duquesne Furnaces of the Carnegie Co., Ltd.," <u>The Iron Trade Review</u> 30 (March 25, 1897): 10; "The Duquesne Furnace Record," <u>The Iron Age</u> 29 (September 10, 1896): 492; "A Duquesne Blast Furnace Record," <u>The Iron Age</u> 77 (April 12, 1906): 1261.

3."The Duquesne Furnace Plant," 9; Gary B. Kulik, "Sloss-Sheffield Steel & Iron Company Furnaces," (Unpublished Paper prepared for the Historic American Engineering Record, 1976): 5;

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5.AI&SI, Iron and Steel Works Directory, (New York: 1951), 369; "Ferromanganese Production Doubled," Blast Furnace and Steel Plant 41 (October 1953): 1207; "Rebuilt Blast Furnace No. 3 Begins Tenth Campaign Duquesne Works," Iron and Steel Engineer 30 (August 1953): 149; "Duquesne Streamlines Ferro Operations," U. S. Steel News 21 (July 1956): 29-33; United States Steel Corporation, "General Arrangement - Ferromanganese Casting Cars - Blast Furnace Area: Drawing #28530, January 14, 1957."; Carnegie-Illinois Steel Corporation. "General Arrangement - 35 Ton Iron Ladle - Blast Furnace Department: Drawing #20327, September 10, 1936"; U.S. Steel Corporation, "Arrangement of Iron Runners - Ferromanganese Car Casting: Drawing #27860, October 14, 1955."; U.S. Steel, "Parallel Primary Crushing and Handling Facilities - Trade Ferromanganese - FeMn Crushing and Screening Plant: Drawing #51866, May 6, 1965."; U.S. Steel Corporation, "Arrangement and Elevations - Trade FeMn Crushing and Storage Facilities - Blast Furnace Department: Drawing #51865, October 6, 1965."

6.AI&SI, Iron and Steel Works Directory, (New York: 1967), 284; "Novel Equipment Features U. S. Steel's New Duquesne Blast Furnace," Iron and Steel Engineer 40 (July 1963): 150; "USS Blast Furnace Has Third Bell," Steel 52 (June 10, 1963): 106; "A Lady Grows in Pittsburgh," U. S. Steel News 27 (January-February, 1962): 16; "Duquesne Works, No. 6 Blast Furnace," Blast Furnace and Steel Plant 51 (September 1963): 780; United States Steel Corporation, "General Arrangement - Plot Plan - 28'-0" Blast Furnace No. 6: Drawing #43024, January 3, 1961."

7.Steve Chomanics, Former Blast Furnace Maintenance Foreman, interview with author, July 18, 1989; "Duquesne and National Works Being Combined," Blast Furnace and Steel Plant 57 (February 1969): 173, 176; AI&SI, Iron and Steel Works Directory, (New York: 1967), 284; AI&SI, Iron and Steel Works Directory, (New York: 1977), 308; John P. Ely, Former General Superintendent of the National-Duquesne Works, interview with author, July 11, 1989; U.S. Steel Corporation, "Iron Desulfurization Facility -

Blast Furnace Area - General Arrangement - Elevation -Duquesne Works: Drawing #67401, May 13, 1978."; U.S. Steel, "Iron Desulfurization Facility - Blast Furnace Area - Calcium Carbide System - Piping Flow Diagram - Duquesne Works: Drawing #67430, May 15, 1978."; U.S. Steel, "Iron Desulfurization Facility -Blast Furnace Area - Pollution Control Schematic - Sequence of Operation - Duquesne Works: Drawing #67454, May 25, 1978."

<u>Historic Name</u>: U.S.S. Corporation, Duquesne Works: Blast Furnace Plant, Combustion Air Production and Delivery System.
<u>Present Name</u>: U.S.X. Corporation, National-Duquesne Works: Blast Furnace Plant; Combustion Air Production and Delivery System.
<u>Location</u>: Upper Works
<u>Construction</u>: 1896, 1931
<u>Documentation</u>: Photographs of blast furnace plant located in HAER No. PA-115-A.

DESCRIPTION

I. <u>Cold Blast Air Facilities</u>:

A. <u>Blowing Engine House Number One</u>: Built by the Keystone Bridge Company and laid out on a east-west axis, the blowing engine house is 65'-0" wide x 174'-2" long x 65'-2 3/8" high to the underside of the truss. Constructed from a concrete foundation, the building's brick exterior encases its steel frame. An upper and lower row of bricked up 4'-5" wide x 15'-0" high segmented archway windows rim the walls of the building. The upper most part of the north and south walls of the building are fitted with 10'-0" high louvers set between the encased steel work. A craneway spans the width and runs the entire length of the building. It carries a crane with a 25-ton capacity. The clearance between the floor of the building and the top of the craneway's rail is 51'-6". The building's gable roof is supported by Fink trusswork that supports ventilation pipes. Five ventilation stacks, laid out linearly on a east-west axis, protrude up through the peak of the roof.
Construction Date: 1895.
Installation of Louvers: 1931.

B. <u>Blowing Engine House Number Two</u>: The 65'-0" wide x 200'-0" long x 65'-2 3/8" high blowing engine house, built by the Keystone Bridge Company, is laid out on an east-west axis. The northern, southern, and western walls of the building are made up of brick construction. The eastern wall of the building has a corrugated metal exterior as a result of a 25'-0" wide x 65'-0" long extension to its eastern side. The concrete foundation of the building supports a steel framework which is encased by the brick walls. Ten foot high louvers are fitted between the encased steel work at the top of the north and south walls. Also fit between the encased steel work of the building's brick walls is an upper and lower row of bricked up 4'-5" x 15'-0" high segmented archway windows. Spanning the width and running the entire length of the building is a craneway carrying a 25 ton capacity crane. The clearance between the floor of the building and the top of the craneway's rail is 51'-6". Fink trusswork supports the building's gable roof and carries ventilation pipes. Five ventilation stacks, laid out linearly on a east-west axis, protrude up through the peak of the roof.

Construction Date: 1895.
Installation of Louvers: 1931.
Building Extension Date: 1951.

1. Turboblower Number One: Sitting on top of a 18'-9" wide x 40'-9" long x 25'-0" high concrete and steel framed platform extending from the south wall of the 1951 addition to the eastern end of blow engine house number two is an Ingersoll - Rand 10,000 hp, 90,000 cfm centrifugal turboblower operating at 2880 rpm. Laid out on a north-south axis, the approximately 10'-0" wide x 25'-0" long x 7'-0" high turboblower produced compressed air at a pressure of 30 psig. It consists of four major parts: the turbine, the steam governing valves, the blower, and the drive shaft.

Installation Date: 1951.

a. Turbine: The turbine is located at the northern end of the platform. It is made up of a rotor consisting of twelve special alloy-steel wheel blades mounted on a common shaft, and an approximately 10'-0" wide x 10'-0" long x 7'-0" high casing which encloses the rotor. The casing is made up of two parts. At the southern or high pressure end of the turbine, the casing is cast steel. At the northern or exhaust end of the turbine, the casing is cast iron. The two ends are permanently bolted and doweled together through a vertical flange. The entire casing is divided horizontally along its centerline with the upper and lower halves bolted together and doweled. Located at the bottom center of the turbine at its southern end is a 10" diameter flanged steam connection. Located at bottom center of the turbine at its northern end is a 72" diameter flanged exhaust steam connection.

b. Steam Admission Valves: Protruding through the top of the turbine casing at its northern end are five, approximately 9" diameter x 1'-6" high steam governing valves. The single seated poppet valves are opened in succession and admit live steam to individual nozzle groups leading to the wheel blades of the turbine. Each valve is actuated by a spring loaded oil piston and cylinder which is automatically controlled by a governor.

c. Blower: The blower is located at the southern end of the platform. It is made up of a rotor consisting of four alloy sheet steel impellers mounted on a common shaft and an approximately 10'-0" wide x 10'-0" long x 7'-0" high cast iron casing which encloses the rotor. The casing is divided vertically by diaphragms into separate compartments in which the impellers revolve, and horizontally along its centerline. The upper and lower halves of the casing are securely bolted and doweled together. Located at the bottom center of the blower at its southern end is a 66" diameter flanged air intake connection which is bolted to a 66" diameter air intake pipe. Air is drawn into the blower through the hooded air intake pipe which runs vertically alongside the outside south wall of the building at its eastern end. Located at the bottom center of the blower at its northern end is a flanged 42" air discharge connection. The compressed air is taken from this connection through a 42" diameter pipe which runs horizontally along the outside of the building's south wall to a pipe bridge where it is connected to the cold blast main.

d. Drive Shaft: The approximately 6" diameter drive shafts from the turbine and blower are connected together at the center of the turboblower by a flexible coupling.

2. Turboblower Number One Lubrication System: Located on the floor of blow engine house number two underneath the turbine is the lubrication system for turboblower number one. Manufactured by the Bowser Company of Fort Wayne, Indiana, the lubrication system consists of two oil coolers, two strainers, an oil conditioner, and a 1/2 hp motor connected to a oil recirculating pump.

Installation Date: 1951.

3. Turboblower Number One Surface Condenser: The approximately 10'-0" wide x 23'-0" long x 8'-0" high Ingersoll - Rand surface condenser is bolted to turboblower number one at its 72" diameter, flanged exhaust steam connection. Laid out on a north-south axis, the centerline of the condenser is located 12'-5" from the floor. It consists of a cast iron shell enclosing a large number of 1/4" diameter tubes. Located on the western side of the surface condenser near its northern end is a 18" diameter flanged inlet and a 18" diameter flanged outlet connection for the service water passing through the tubes. Two 4" diameter flanged connections for the purpose of condensate removal are located on the underside of the surface condenser shell near its centerline.

Installation Date: 1951.

a. Air Ejectors: Attached to the surface condenser of turboblower number one on its eastern side near its centerline are two Ingersoll - Rand, Series M, Steam Jet Air Ejectors. Laid out vertically, each 3'-3 9/16" long ejector has a 2" screwed

steam inlet connection at its lower end and a 4" flanged discharge connection at its upper end. Each is attached to the surface condenser by a 4" flanged suction inlet. The centerline of the suction inlet is 2'-7 5/8" below the flange of the discharge connection.
Installation Date: 1968.

4. Turboblower Number One Condensate Removal Motor/Pump Assemblies: Two condensate removal motor/pump assemblies, laid out on an east-west axis, are located on the floor underneath the surface condenser. The centerline of the northern most assembly is located 3'-8" from the centerline of the surface condenser. The centerline of the southern most assembly is located 4'-4" from the centerline of the surface condenser. Each assembly consists of a 17 hp steam turbine, manufactured by the Terry Steam Turbine Company of Hartford, Connecticut, operating at 1450 rpm. The turbine is connected by a gear drive to an Ingersoll - Rand 240 gpm centrifugal pump.
Installation Date: 1951.

5. Turboblower Number Two: Turboblower number two is located 41'-5" west of turboblower number one and is laid out parallel to it. It sits on top of a 18'-9" wide x 40'-9" long x 25'-0" high steel framed platform extending from the south wall of the building. The manufacturer, capacity, and model of the turboblower are exactly the same as turboblower number one. See I-B-1 for description.
Installation Date: 1954.

6. Turboblower Number Two Lubrication System: See I-B-2 for description.
Installation Date: 1954.

7. Turboblower Number Two Surface Condenser: See I-B-3 for description.
Installation Date: 1954.

8. Turboblower Number Two Condensate Removal Motor/Pump Assemblies: See I-B-4 for description.
Installation Date: 1954.

9. Remains of Turboblower Number Three: The remains of an Ingersoll - Rand 15,750 hp, 125,000 cfm centrifugal turboblower rated at 2710 rpm sits on top of a 18'-9" wide x 41'-0" long x 25'-0" high concrete and steel framed platform extending from the south wall of the building. The remains are located 34'-6" west of turboblower number two. They are laid out on a north-south axis and consist of the bottom halves of the turbine and blower casings.

Installation Date: 1955.

10. Turboblower Number Three Lubrication System: The lubrication system for turboblower number three is located on the floor of the building underneath the remains of the turbine. It is manufactured by the Bowser Company of Fort Wayne, Indiana, and consists of two oil coolers, two strainers, an oil conditioner, and a 1/2 hp motor connected to a oil recirculation pump. Installation Date: 1955.

11. Turboblower Number Three Surface Condenser: A 20,000 square foot capacity Ingersoll - Rand surface condenser is bolted to the 72" diameter flanged steam connection located on the underside of the bottom casing for the turbine. The centerline of the condenser, which is laid out on a north-south axis, is located 11'-1" from the floor. The condenser consists of a cast iron shell which encloses a large number of 1/4" diameter tubes. A 24" flanged inlet and a 24" flanged outlet connection are located on the western side of the surface condenser near its northern end for the purpose of circulating service water through the tubes. Located on the underside of the surface condenser shell near its center are two 4" diameter flanged condensate removal connections.

Installation Date: 1955.

a. Air Ejectors: Two Ingersoll - Rand, Series M, Steam Jet Air Ejectors are attached to the eastern side of the surface condenser near its centerline. The 3'-3 9/16" long ejectors are laid out vertically. Each ejector has a 2" diameter screwed steam inlet connection at its lower end and a 4" diameter flanged discharge connection at its upper end. Each ejector is attached to the surface condenser by a 4" diameter flanged suction inlet. The centerline of the suction inlet is 2'-7 5/8" below the flange of the discharge connection.

Installation Date: 1968.

12. Turboblower Number Three Condensate Removal Motor/Pump Assemblies: Located on the floor underneath the surface condenser are two condensate removal motor/pump assemblies. Laid out on a east-west axis, the assemblies straddle the centerline of the surface condenser and are spaced 6'-4 13/16" apart. The northern most assembly consists of a 25 hp Westinghouse Type CS Line Start Induction Motor rated at 1755 rpm which is connected by a gear drive to an Ingersoll - Rand 370 gpm centrifugal pump. The southern most assembly consists of a 24 hp steam turbine, manufactured by the Terry Steam Turbine Company of Hartford, Connecticut, rated at 1750 rpm which is connected by a gear drive to an Ingersoll - Rand 370 gpm centrifugal pump.

Installation Date: 1955.

13. Turboblower Number Four: Located 52'-3" west of turboblower number three and laid out on a north-south axis is an Elliott 24,900 hp, 155,000 cfm axial turboblower rated at 4350 rpm. The 14'-10 1/2" wide x 31'-8 7/8" long x 8'-8" high turboblower sits on top of a 25'-0" high concrete and steel framed platform extending from the south wall of the building. It produced compressed air at a pressure of 55 psig. It consists of four major parts: the turbine, the steam governing valves, the compressor, and the drive shaft.
Installation Date: 1962.

a. Turbine: Located at the northern end of the platform, the turbine is made up of a rotor consisting of eight special alloy-steel wheel blades mounted on a common shaft, and a 14'-10 1/2" wide x 13'-6" long x 8'-8" high casing which encloses the rotor. The casing is divided horizontally along its centerline. The upper and lower halves of the casing are fitted together and coated with a high temperature sealing compound. Located at the western end of the turbine casing about its centerline is a 14" diameter flanged steam inlet connection. A 68" wide x 112" long flanged exhaust steam connection is located on the underside of the casing near its southern end.

b. Steam Admission Valves: Seven steam admission valves for turboblower number four are laid out linearly on a east-west axis at the northern end of the turbine just underneath the top casing. The approximately 9" diameter x 1'-6" high single seated valves are opened individually and admit steam from a common horizontal steam chest, which is integral with the upper half steam inlet end of the casing. The valves are actuated by cams which are located on a common shaft connected to a pinion shaft through a rigid coupling. The shaft is rotated through the necessary travel by a gear segment which is joined by a connecting rod with the governor valve.

c. Compressor: The compressor is located at the southern end of the turboblower. It is composed of an inlet casing, a discharge casing, a stator shell, and a rotor. The top half of the inlet casing and the top half of the discharge casing are permanently bolted together on a vertical split line to form the top half of the compressor. The bottom half of the inlet casing and the bottom half of the discharge casing are arranged in a like manner. The horizontal split of the casing is made up metal to metal and bolted together. The stator shell is located inside the compressor casing along the horizontal split. It carries eleven adjustable buckets or blades. Adjustment of the buckets controls the output and air compression delivered by the machine. An approximately 3'-0" diameter x 12'-2" long cylindrically shaped rotor drum, machined down into a shaft at each of its ends, is located inside of the stator shell. The drum carries rows of stationary stator blades around its circumference along its entire length. The blades direct the incoming air as it passes through the rotor. Located at the bottom center of the compressor casing at its southern end is an 84" diameter flanged air intake connection. Air is drawn into the compressor through a hooded air intake pipe which runs vertically alongside the outside south wall of the building at its western end. Located at the bottom center of the compressor casing at its northern end is a 60" diameter flanged air discharge connection. The compressed air is taken from this connection through a 60" diameter pipe which is run horizontally along the outside of the building's south wall to a pipe bridge where it is connected to the cold blast main.

d. Drive Shaft: The 7" diameter drive shafts from the turbine and compressor are connected together at the center of the turboblower by a flexible coupling.

14. Turboblower Number Four Lubrication System: The lubrication system for turboblower number four is located on the floor of the building just east of the compressor. Manufactured by the Bowser Company of Fort Wayne, Indiana, it consists of an 800 gallon oil tank, an oil cooler, and a 3/4 hp motor connected to a oil recirculating pump.
Installation Date: 1962.

15. Turboblower Number Four Surface Condenser: A 30,000 sq. ft. capacity Elliott surface condenser is bolted to the exhaust steam connection located on the underside of the turbine casing. Laid out on a north - south axis, its centerline is located approximately 12'-0" above the floor of the building. The 27'-3" long x approximately 10'-0" diameter condenser consists of a cast iron shell which encloses a large number of 20'-3" long x 1/4" diameter tubes. Located on the eastern and western sides of the condenser at its northern end are a 30" diameter flanged inlet and a 30" diameter flanged outlet connection which are used for circulating service water through the tubes. Located on the underside of the surface condenser shell near its center are two 4" diameter flanged condensate removal connections.
Installation Date: 1962.

a. Air Ejectors: Two Elliott steam jet air ejectors are connected to the eastern side of the surface condenser near its centerline. The 9 7/8" long ejectors are laid out vertically. Each ejector has a 1/2" diameter threaded steam inlet connection at its lower end and a 1 1/2" diameter threaded discharge connection at its upper end. Each ejector is connected to the condenser by a 1" diameter threaded suction inlet. The

centerline of the suction inlet is 6 5/8" below the discharge connection.
Installation Date: 1962.

16. Turboblower Number Four Condensate Removal Motor/Pump Assemblies: Two condensate removal motor/pump assemblies, laid out on a east-west axis, are located on the building floor, east of the surface condenser. The northern and southern units are each located 3'-0" from the centerline of the condenser. The northern unit consists of a 25 hp Elliott lnduction Motor rated at 1185 rpm which is connected by a gear drive to an Ingersoll - Rand 600 gpm centrifugal pump. The southern unit consists of a 25 hp Elliott Steam Turbine rated at 1150 rpm which is connected by a gear drive to a 600 gpm lngersoll - Rand centrifugal pump.
lnstallation Date: 1962.

C. Blowing Engine House Number Three: Built by the American Bridge Company, blow engine house number three is 104'-6" wide x 244'-7" long overall. The northern, eastern, and western walls of the steel framed building are constructed of brick. The southern wall is constructed of corrugated metal. The building is divided up into two sections. At its north end is a 42'-0" wide x 104'-6" long x 60'-8" high (to the underside of the truss) bay which is laid out on a east-west axis. The encased steel framework of the bay supports Fink trusswork for its gable roof. Three rows of 4'-0" wide x 13'-8" high segmented archway windows rim the north, east and west walls of the bay.

Running perpendicular to the bay at the northern end of the building is a 104'-6" wide x 202'-7" long x 44'-0" high (to the underside of the truss) bay which is laid out on a north-south axis. The steel framework of the bay supports pratt trusswork for its gable roof with monitor. An upper and lower row of 4'-0" wide x 13'-8" high segmented archway windows are cut into the building's east and west walls. A craneway spanning the width of the bay runs its entire length and carries a 25-ton crane. The clearance between the floor of the building and the top of the craneway's rail is 30'-0". Located along the western wall in the southwest corner of the bay is a 20'-0" wide x 80'-0" long x 10'-0" high cinder block structure which was used for office space. Located along the southern wall of the building is a 20'-0" wide x 80'- 0" long x 10'-0" high cinder block structure which was used as a locker room.
Construction Date of North Bay: 1897.
Construction Date of South Bay Extension: 1908.

I1. Gas Cleaning Facilities:

A. Uptakes and Downcomers for Blast Furnace's Number One, Three, and Four: Extending from the top of each blast furnace are four 5'-6" diameter refractory brick lined pipes called uptakes. The uptakes are tied together at each furnace by two 7'-6" diameter refractory brick lined pipes called downcomers. The downcomers at each furnace are tied together into one brick lined pipe before entering the dustcatcher.

B. Dustcatchers for Blast Furnaces Number One, Two, Three, and Four: A 26'-5" diameter, 17,470 cu. ft. dustcatcher is located adjacent to blast furnaces one through four.
Installation Dates: 1901 and 1924.

C. Dustcatcher for Dorothy Six: A 40'-0" diameter, 78,860 cu. ft. dustcatcher, designed and manufactured by John Mohr and Sons, is located on the grounds of the remains of Dorothy Six.
Installation Date: 1962.

D. Rough Gas Main for Blast Furnaces One, Three, and Four: Exiting each of the dustcatchers at blast furnaces one, three, and four is a approximately 6'-0" inside diameter refractory brick lined rough gas pipe. The pipes tie together into the rough gas main before branching off into the top of one of the Venturi Gas Washers located at either blast furnace number three or blast furnace number four.
Installation Date: 1908. However, there have been numerous replacements and rerouting of the rough gas mains in succeeding years.

E. Rough Gas Main for Dorothy Six: Exiting the dustcatcher located on the grounds of the remains of Dorothy Six is a 8'-4" inside diameter refractory brick lined rough gas pipe. The pipe leads directly to the Gas Washer for Dorothy Six.
Installation Date: 1962.

F. Venturi Gas Scrubbers at Blast Furnaces Numbers Three and Four: 150,000 scfm capacity venturi gas scrubbers, manufactured by the American Air Filter Company, are located approximately 65'-0" east of blast furnace number three and blast furnace number four. The "carbofrax" brick lined gas washer is designed to receive rough gas at temperatures up to 500 degrees F.
Installation Date: 1971.

G. Gas Cooling Towers at Blast Furnaces Numbers Three and Four: 180,000 cfm capacity gas cooling towers, manufactured by the American Air Filter Company, are located west of the venturi washers at blast furnaces numbers three and four. The tile lined gas cooling tower is designed to cool the cleaned gas down to 112 degrees F.
Installation Date: 1971.

H. Pump Tank at Gas Cooling Towers: Located near each of the gas cooling towers is a 3'-0" diameter pump tank. The pump tank at the gas cooling tower near blast furnace number three is 16'-2" high. The pump tank at the gas cooling tower near blast furnace number four is 19'-10" high. The tanks hold water which has been used in the gas cooling towers so that it can be redirected to pumps feeding the venturi gas washers.
Installation Date: 1971.

I. Pump House Building for Gas Cleaning Equipment at Blast Furnaces Numbers Three and Four: A 15'-0" wide x 45'-0" long x 12'-0" high concrete block building, laid out on a north - south axis, is located between the gas cleaning facilities at blast furnace numbers three and four. The building contains pumps for the venturi gas washers and the gas cooling towers.
Construction Date: 1961.

1. Venturi Gas Scrubbers Pumps: Along the eastern wall of the building, laid out on a north-south axis, are three 1950 gpm Wilson-Snyder pumps, each powered by a 100 hp motor.
Installation Date: 1971.

2. Gas Cooling Tower Pumps: Along the western wall of the building, laid out on a north-south axis, are three 4150 gpm Wilson-Snyder pumps, each powered by a 75 hp motor.
Installation Date: 1971.

J. Strainer Building: Located approximately 90'-0" south and 30'-0" west of the gas cooling tower at blast furnace number four is the 15'-0" wide x 30'-0" long x 12'-0" high concrete block strainer building. The building, which is laid out on a north-south axis contains two 16" motorized Helan strainers. Construction Date: 1971.
Installation of Strainers: 1971.

K. Primary Gas Washer for Dorothy Six: Located 35'-2 1/8" northwest of the dustcatcher on the grounds of the remains of Dorothy Six is a 21'-0" diameter, 190,000 scfm venturi type primary gas washer manufactured by the Chemical Construction Corporation.
Installation Date: 1962.

L. Gas Cooling Tower for Dorothy Six: A 24'-0" inside diameter gas cooling tower is located 68'-0" northwest of the primary gas washer on the grounds of the remains of Dorothy Six. Manufactured by the Chemical Construction Corporation, the

cooling tower has a capacity of 190,000 scfm.
Installation Date: 1962.

M. Pump House Building for Dorothy Six: The 33'-6" wide x 36'-0" long pump house makes up the ground floor of the East Service Building which is located between the primary gas washer and the gas cooling tower at Dorothy Six. It contains motor/drive/pump assemblies which relate to the gas cleaning process as well as blast furnace cooling. Gas cleaning related equipment includes two 2400 gpm Wilson-Snyder gas cooling tower centrifugal pumps each powered by a 100 hp Westinghouse Life Line Motor rated at 1780 rpm and two 2400 gpm Wilson-Snyder primary gas washer centrifugal pumps each powered by a 200 hp General Electric Custom 8000 induction motor rated at 1770 rpm.
Construction and Installation Date: 1962.

N. Ferromanganese Gas Cleaning Plant: A 90'-0" high rectangular steel framed structure covering 150'-0" sq. ft. is located approximately 30'-0" south of blow engine house number one. The six story high open air structure contains five ferromanganese gas cleaning systems arranged in parallel and the remains of five ferromanganese briquetting systems also arranged in parallel. The equipment making up each gas cleaning system is laid out on a north - south axis and consists of a 8'-0" diameter refractory brick lined rough gas main, a 15'-0" diameter x 60'-0" high gas conditioning tower, a 3'-6" diameter refractory brick lined downcomer pipe, and an electrical precipitator. The equipment making up the remains of each briquetting system, also laid out on a north-south axis, consists of a rotary screw conveyor manufactured by the Fuller Company and a bottom fired kiln manufactured by the Perkins Dryer Company.
Construction Date: 1953.

O. Electrical Precipitator: Located approximately 30'-0" east of (and between) the hot blast stoves for blast furnaces numbers three and four is an approximately 20'-0" electrical precipitator.
Installation Date: 1951.

III. Water Treatment Facilities:

A. Slurry Water Pumps: Located directly underneath each of the gas cooling towers at blast furnaces numbers three and four are two 1300/2000 gpm slurry water pumps manufactured by the Wemco Company. Each pump is powered by a 60 hp motor.
Installation Date: 1971.

B. Quick Dump Sump and Lift Pumps: A 14'-0" wide x 16'-0" long x 6'-9" deep quick dump sump is located approximately 15'-0" west of the gas cooling towers at blast furnaces number three and four. Each of the concrete constructed sumps contains two 600 gpm, 1100 x 72" vertical cantilever pumps manufactured by the Galligher Company. Each pump is powered by a 50 hp General Electric motor rated at 1800 rpm. Located just west of the gas cooler on the grounds of the remains of Dorothy Six is a 8'-0" wide x 20'-0" long x 5'-6" deep quick dump sump constructed of concrete. The sump contains two 500 gpm vertical cantilever sludge pumps manufactured by Morris Pump Inc. Each pump is powered by a 15 hp Reliance Electric motor operating at 1200 rpm. Installation Date of Quick Dump Sump and Lift Pumps at blast furnaces numbers three and four: 1971.

Installation Date of Quick Dump Sump and Lift Pumps at Dorothy Six: 1961.

C. Clarifier Number One, Sludge Pumps, and Associated Chemical Feed Equipment: Clarifier Number One is manufactured by the Dorr-Oliver Company and is located approximately 100'-0" west of the remains of Dorothy Six. It consists of a 90'-0" diameter x 12'-0" high concrete basin. The floor of the basin slopes slightly toward the center. Located within the clarifier is a chain driven sludge rake powered by a 3 hp, 1750 rpm General Electric motor connected to a gear reducer. Encircling the circumference of the clarifier is a 2'-6" wide x 3'-0" deep launderer. Two 50 gpm sludge pumps, powered by 10 hp motors, are located in a tunnel beneath the clarifier. Located near the clarifier on its southeastern side is a 8'-0" diameter x 16'-0" high hydrochloric acid tank with a capacity of 6000 gallons. Two small pumps powered by 1/2 hp motors deliver the acid to the clarifier.

Construction Date of Clarifier: 1957.

Installation Date of Hydrochloric Acid Tank: 1980.

D. Clarifier Slurry Lift Station and Lift Pumps: An approximately 12'-0" wide x 25'-0" long x 6'-0" deep sump made of concrete construction is located just north of clarifier number one. Located within the sump are two 1500 gpm Nagle Sump Pumps which are powered by a 30 hp U. S. Electrical Enclosed Motor rated at 720 rpm.

Construction and Installation Date: 1957.

E. Clarifier Number Two and Sludge Pumps: Located just northeast of clarifier number one is a 90'-0" diameter x 12'-0" high basin with a floor that slopes slightly toward the center. Manufactured by the Eimco Company, the clarifier is equipped with a sludge rake powered by a 3 hp motor which is connected to a gear reducer. Encircling the circumference of the basin is a 2'-6" wide x 2'-0" deep launderer. Two 50 gpm horizontal sludge pumps manufactured by Morris Pump Inc., and powered by 10 hp U. S. Electrical Company motors rated at 1800 rpm, are located in a

tunnel beneath the clarifier.
Installation Date: 1979.

F. Polymer Feed Building and Polymer Feed Equipment: The 12'-8" wide x 20'-8" long x 10'-0" high polymer feed building is constructed of concrete block and is located just north of clarifier number two. Located along the southeastern wall of the building is a polyelectrolyte feed system manufactured by the Pennwalt Corporation. The system includes a series A-690 volumetric feeder, two 100 gallon fiberglass tanks, one heater unit, one type RG portable mixer, one Viking model HL-32V transfer pump, and two Viking model H-32D metering pumps. Two 1 gpm Moyno Progressing Cavity polyelectrolyte feed pumps, manufactured by Robbins and Myers Inc., are located along the northeastern wall of the building. Each pump is powered by a U. S. Electrical Company 1/4 hp motor rated at 1800 rpm.
Construction and Installation Dates: 1979.

G. Filter Cake House and Sludge Dewatering Equipment: Located approximately 30'-0" west of, and located between clarifier numbers one and two is the 30'-0" wide x 36'-0" long filter cake house. The two and one-half story corrugated metal exterior, steel framed building is laid out on a north-south axis. Each of the building's two bays is covered by a pitched roof set at different elevations. Located on the ground floor of the western bay are two vacuum pumps laid out on a north-south axis. The southern vacuum pump, manufactured by the Ingersoll - Rand Corporation, is powered by a 100 hp Westinghouse Life Line Motor rated at 1775 rpm. At the northern end of the ground floor is Size 4001 Nash -Hytor vacuum pump powered by a 150 hp U. S. Electrical Enclosed Motor rated at 1200 rpm. The western bay's second floor houses two 4'-0" diameter x 6'-0" high air receivers manufactured by the Eimco Corporation of Salt Lake City, Utah. Located adjacent to each receiver is a 5 hp, 1740 rpm Duty Master motor with an associated 1" diameter piping. The eastern bay of the building is composed of a top floor set directly above an open dumping space. Set along the upper western wall of the eastern bay are 4'-0" diameter x 6'-0" high condensate receivers which are connected by a 16" pipe to the air receivers on the second floor of the western bay and to the two vacuum disc filter assemblies located on the floor adjacent to them. Laid out on a north - south axis, each vacuum disc filter assembly is manufactured by the Eimco Corporation and consists of a set of five 8'-6" diameter discs set in a basin. The eastern side of the basin consists of a slurry tub, the western side consists of a chute leading directly to the dumping area below. Associated with each filter assembly is a set of compressed air and vacuum piping.
Construction Date of Building: 1957.

Installation Date of Filters and Associated Equipment: 1979.

H. Evaporative Hotwell, Hotwell Pumps, and Hotwell Strainer: The hotwell for the evaporative water treatment recycle system is located approximately 50'-0" northeast of the polymer feed building. It is a large underground concrete basin that measures 45'-0" wide x 62'-6" long x 25'-0" high and is composed of five cells, a distribution cell and four pump cells which are separated by four Armco Model No. 35-05 sluice gates. Located above ground over each of the pump cells is a 5000 gpm Wilson-Snyder vertical turbine pump which is powered by a 200 hp U. S. Motor rated at 1170 rpm. A 24" Kinney Automatic Strainer is located at the discharge or northern end of the hotwell.

Construction and Installation Dates: 1979.

I. Evaporative Cooling Tower: The cooling tower for the evaporative water treatment recycle system is located approximately 30'-0" west of blow engine house number three. Manufactured by the Ceramic Cooling Tower Company, the cooling tower is a six cell, forced draft structure laid out linearly on a north-south axis. It has capacity rating of 15,000 gpm. The Tuf-Lite Company fans at the top of each cell are powered by a 75 hp Reliance Duty Master Motor rated at 900/1800 rpm. The tower is designed for an inlet temperature of 115 degrees F. and an outlet temperature of 90 degrees F. Installation Date: 1979.

J. Evaporative Coldwell and Coldwell Pumps: The coldwell for the evaporative water treatment recycle system is adjacent to the evaporative cooling tower on its eastern side and is laid out on a north-south axis. An underground concrete basin measuring 57'-6" wide x 67'-0" long x 24'-0" deep, it is divided into five cells which are separated by sluice gates identical to those in the hot well. Over each of the cells is located an above ground vertical turbine pump. The three most northern pumps are manufactured by Wilson-Snyder and rated at 5000 gpm. The other two pumps are also manufactured by Wilson-Snyder but are rated at 6000 gpm. Each of the pumps is powered by a 300 hp U. S. Electrical direct drive motor operating at 1200 rpm.

Construction and Installation Date: 1979.

K. Make-Up Water and Blow-Down Water Monitoring Building With Associated Chemical Feed Equipment: Located just north of the coldwell pumps for the evaporative water treatment recycle system is a 14'-0" wide x 42'-0" long x 10'-0" high cinder block building set upon a concrete foundation. Metering equipment for the system's make-up and blow down water pipelines is located along the western wall of the building. A 2,000 gallon capacity carbon steel chemical dispersant tank is located in the southeast corner of the building. The feed pumps which were associated with the tank have been removed.

Construction and Installation Date: 1979.

L. Sulfuric Acid Feed Station: Located at the southern end of the evaporative cooling tower, the sulfuric acid feed station consists of a Sharpsville manufactured 4,000 gallon capacity carbon steel sulfuric acid storage tank set inside of a lime filled pit, and two 10.3 gph metering pumps manufactured by the Milton Roy Company. The pumps are powered by two 1/2 hp integral motors rated at 1725 rpm.

Installation Date: 1979.

M. Blast Furnace Numbers Three and Four Chemical Additive Building and Associated Chemical Feed Equipment: Located just west of the gas cleaning equipment at blast furnace number three is an approximately 10'-0" wide x 30'-0" long x 10'-0" high cinder block building. A 5'-4" diameter x 12'-0" long carbon steel chemical storage tank with a capacity of 2000 gallons, manufactured by the Betz Company, is located in the southeast corner of the building.

Construction and Installation Date: 1979.

N. Evaporative Control Building and Associated Electrical Equipment: The 14'-0" wide x 120'-0" long x 10'-0" high control building for the evaporative water treatment recycle system is attached to the western side of blow engine house number three. Set upon a concrete foundation, the cinder block building houses the main control panel for the evaporative water treatment recycle system at its northern end and electrical circuit breakers for the system at its southern end.

Construction and Installation Date: 1979.

O. Non-Evaporative Gas Washer Hotwell and Gas Washer Hotwell Pumps: The gas washer hotwell for the non-evaporative water treatment recycle system is located approximately 40'-0" northeast of the hot blast stoves for Dorothy Six. It is composed of an 184,000 gallon capacity underground concrete basin measuring 32'-6" wide x 40'-0" long x 19'-0" high. Water is allowed into or diverted away from the hotwell by separate sluice gates. Two 3000 gpm Wilson-Snyder vertical pumps are located above ground over the hotwell. Each pump is powered by a 400 hp U. S. Electrical Titan Line motor rated at 1180 rpm.

Construction and Installation Date: 1980.

P. Non-Evaporative Gas Cooler Hotwell and Gas Cooler Hotwell Pumps: The gas cooler hotwell for the non-evaporative water treatment recycle system is located adjacent to the gas washer hotwell on its northern side. The 19'-6" wide x 40'-0" long x

19'-0" high underground concrete basin has a capacity of 110,900 gallons. Two 2400 gpm Wilson-Snyder vertical pumps are located above ground over the hotwell. A 200 hp U. S. Electrical Titan Line motor rated at 1185 rpm powers each pump.

Construction and Installation Date: 1980.

Q. Non-Evaporative Spray Water Well and Spray Water Pumps: Located adjacent to the gas cooler hotwell on its northern side is the spray water well for the non-evaporative water treatment recycle system. It is composed of 184,000 gallon capacity underground concrete basin measuring 32'-6" wide x 40'-0" long x 19'-0" high. Sluice gates divide the basin into three cells, a gas washer spray water cell, a gas cooler spray water cell, and a standby cell. Three 7000 gpm Wilson-Snyder vertical pumps are located above ground over each cell. Each pump is powered by a 150 hp U. S. Electrical Titan Line motor rated at 1180 rpm.

Construction and Installation Date: 1980.

R. Non-Evaporative Cooling Tower: The cooling tower for the non-evaporative water treatment recycle system is located adjacent to the gas washer hotwell, gas cooler hotwell, and spray water well on their eastern side. Manufactured by Resorcon Inc., it is composed of two wet surface air coolers: one for gas washer water and one for gas cooler water. Each unit is made up of four cells sandwiched between two shell and tube type heat exchangers. The fans at each cell, manufactured by the Tuf-Lite Company, are each powered by a 60 hp Reliance Duty Master motor rated at 890/1775 rpm. The capacity of the gas washer unit is 3000 gpm. The capacity of the gas cooler unit is 2400 gpm. Both units are designed for an inlet temperature of 125 degrees F. and an outlet temperature of 90 degrees F.

Installation Date: 1980.

S. Dorothy Six Chemical Dispersant Building and Associated Chemical Feed Equipment: Constructed of cinder block and set on a concrete foundation, the 16'-0" wide x 20'-8" long x 10'-8" high chemical dispersant building for the non-evaporative water treatment recycle system is located just north of the gas cooling tower at Dorothy Six. Three chemical storage tanks, two with a capacity of 1000 gallons and one with a capacity of 560 gallons, are located within the building. The chemical feed pumps which were associated with each tank have been removed.

Construction and Installation Date: 1979.

T. Non-Evaporative Control Building and Associated Chemical Storage Tanks: Located just north of the non-evaporative cooling tower, the two story control building is 28'-0" wide x 68'-0" long. Constructed of cinder block, it is set on a concrete foundation. The main control panel for the non-evaporative water treatment recycle system is located on the first floor at the southern end of the building. The northern end of the building's first floor is occupied by electrical circuit breakers. Located directly above the main control panel on the second floor of the building is the metering equipment for the system's make-up and blow-down water pipelines. An 8'-0" diameter x 12'-0" high 4500 gallon capacity carbon steel sodium hydroxide tank, manufactured by Sharpsville Steel Fabricators, is located on the second floor of the building just north of the make-up and blow-down metering equipment. Located at the base of the tank are two small sodium hydroxide feed pumps which are each powered by a 1/2 hp General Electric Statotrol motor rated at 1735 rpm. Located just east of the control building near its centerline is a 5'-4" diameter x 12'-0" high corrosion inhibitor storage tank. At the base of the 2000 gallon capacity carbon steel tank are three 1.4 gph feed pumps which are each powered by 1/2 hp motor rated at 1725 rpm. Also just east of the control building at its southern end is a 560 gallon capacity stainless steel scale inhibitor storage tank. Located at the base of the 4'-0" diameter x 5'-0" tank are three 1.4 gph feed pumps, each powered by a 1/2 hp motor rated at 1725 rpm.

Construction and Installation Date: 1980.

IV. <u>Hot Blast Air Facilities</u>:

A. <u>Hot Blast Stoves at Blast Furnace Number One</u>: Four 21'-0" diameter x 84'-0" high hot blast stoves are laid out linearly just south of blast furnace number one. Each stove is equipped with a chimney stack extending from the top of the stove's dome, a 28" diameter cold blast air connection, a 32" inside diameter refractory brick lined hot blast air connection, and a 33" inside diameter refractory brick lined burner connection. An 18" diameter pipeline, complete with valving, runs from the cold blast main to the each stove's hot blast connection. Cold blast air was mixed with the hot blast air through this line in order to equalize the temperature of the hot blast while the stove provided combustion air to the furnace. The 12,000 scfm capacity burner and motor powered combustion air fan located at the burner connection of each stove was designed by Arthur G. McKee and Sons Inc. All connections between the stoves and blast furnace number one have been severed.

Installation Date of Stoves: 1901.

Installation Date of Burners and Combustion Air Fans: 1956.

B. <u>Hot Blast Stoves at the Remains of Blast Furnace Number Two</u>: Laid out linearly just north of the remains of blast furnace number two are four 21'-0" diameter x 96'-0" high Diehl Central Draft hot blast stoves. Built by the Riter-Conley Company, each stove has a total heating surface of 56,750 sq. ft. Each stove is equipped with a 5'-0" diameter x 150'-0" high stack located on its eastern side, a 28" diameter cold blast connection, a 32" inside diameter refractory brick lined hot blast connection, and a 33" inside diameter refractory brick lined burner connection. An 18" diameter pipeline, complete with valving, runs from the cold blast main to each stove's hot blast connection. A 12,000 scfm capacity burner and motor powered combustion air fan, designed by Arthur G. McKee and Sons Inc., is located at the burner connection of each stove. The stoves serviced blast furnace number one after the demise of number two furnace.

Installation of Stoves: 1896.
Installation of Burners and Combustion Air Fans: 1956.

C. Hot Blast Stoves at Blast Furnace Number Three: Four 21'-0" diameter x 96'-0" high Diehl Central Draft hot blast stoves are laid out linearly just south of blast furnace number three. Built by the Riter-Conley Company, each stove has a total heating surface of 56,750 sq. ft. The stack, cold blast connection, hot blast connection, and burner connection at each stove adheres to the requirements described in IV - C. A mixing system, designed by the Brassert-Vincent Company, connects the cold blast connection to the hot blast connection at each stove. The 12,000 scfm capacity burner and motor powered combustion air fan located at the burner connection of each stove was designed by John Mohr and Sons Inc.

Installation of Stoves: 1897.
Installation of Mixing System: 1959.
Installation of Burners and Combustion Air Fans: 1954.

D. Hot Blast Stoves at Blast Furnace Number Four: Four 21'-0" diameter x 121'-0" high hot blast stoves, installed by the William M. Bailey Company of Pittsburgh, Pa., are laid out linearly just north of blast furnace number four. Each stove has a total heating surface of 150,428 sq. ft. Each stove is equipped with a 5'-0" diameter x 150'-0" high stack located at its northeastern side, a 36" diameter cold blast connection, a 42" inside diameter refractory lined hot blast connection, and a 40" inside diameter refractory lined burner connection. A mixing system connecting the cold blast connection to the hot blast connection at each stove was designed by the Brassert-Vincent Company. A 24,000 scfm Askania burner and motor powered combustion air fan is located at the burner connection at each stove.

Installation of Stoves: 1959.
Installation of Mixing System: 1959.
Installation of Burners and Combustion Air Fans: 1968.

E. Hot Blast Stoves at the Remains of Dorothy Six: Three 32'-0" diameter x 130'-0" high hot blast stoves are laid out linearly just southwest of the remains of Dorothy Six. Built by John Mohr and Sons Inc., each stove has a total heating surface of 450,781 sq. ft. A 12'-11" diameter waste gas stack serving all of the stoves is located just southwest of them. Each stove is equipped with a 42" diameter cold blast connection, a 54" inside diameter refractory lined hot blast connection, and a 56" inside diameter refractory lined burner connection. A mixing system running from the cold blast connection to the hot blast connection at each stove was designed and installed by John Mohr and Sons Inc. Located at each stove is a 55,000 scfm burner and motor powered combustion air fan designed and built by the Zimmermann and Jansen Company of West Germany.

Installation of Stoves and All Related Equipment: 1962.

HISTORY

Essentially, the production and delivery of combustion air to the blast furnace at modern plants like the Duquesne Works has consisted of supplying compressed air to a regenerative heating stove, using waste gas from the blast furnace as fuel, which preheated it before it was delivered to the blast furnace's tuyeres where it was introduced into the furnace to combine with the coke, thus creating the combustion necessary to smelt the limestone, manganese and/or iron ore. The historical development of this process at Duquesne, as in other plants, became progressively more complex. This was due, in part, because of a need to develop a more efficient and productive system of pig iron manufacturing. More recent developments, however, were due to wider societal pressures for improvements in the quality of the environment.

The facilities provided for the production and delivery of combustion air at the time of the start-up of the four unit blast furnace plant at Duquesne in 1896 included ten vertical steam driven blowing engines, four regenerative hot blast stoves per furnace, and one dust catcher per furnace. The process began at one of the two original blowing engine houses. Within each blowing engine house (numbers one and two) were located five compound condensing steam driven vertical blowing engines manufactured by the E. P. Allis Company of Milwaukee, Wisconsin. Two blowing engines furnished the necessary air to one of the furnaces by compressing air drawn from the atmosphere to a pressure of 15 psi and delivering it at a maximum rate of 25,000 cubic feet of air per minute. The other two blowing engines (one in each blowing engine house) were on standby status. Air emanating from the blowing engines at a temperature of 100 degrees F. was conveyed to the four regenerative hot blast stoves assigned to each blast furnace by means of a pipeline called the cold blast main. Separate branches, off the cold blast main, each regulated by a value, introduced the air into each stove.

The 21'-0" diameter x 96'-0" high domed Cowper-Kennedy hot blast stoves were constructed of a steel plate shell which enclosed a central combustion chamber surrounded by brick checkerwork consisting of 9" square holes with rounded corners between the courses of firebrick. In order to pre-heat the cold blast, the brick inside of the stoves was heated by means of burning the waste gas flowing from the top of the blast furnace. The gas, which left the furnace top at average temperatures of 500 degrees F., was first cleaned of large entrained particulate by taking it from the top of the furnace through a 10'-0" diameter refractory brick lined pipe called a downcomer into the 28'-0" diameter dust catcher. Upon entering the larger diameter dust catcher the velocity at which the gas was traveling slowed, thereby allowing the larger particulate to drop to the bottom of it as the gas rose out of its top through a 10'-0" diameter gas main leading to the burner connection on the hot blast stoves. The gas was then burned up through the combustion chamber with the aid of combustion air drawn into the burner by an electrically motor powered fan located at each stove. In the process, it was deflected by the dome downwards through the holes in the checkerwork surrounding the combustion chamber. When the checkerwork had become sufficiently hot, the cold blast air was admitted into the stove. It also rose up through the combustion chamber to the dome which deflected it downwards through the holes in the checkerwork before it passed out of the stove's valve regulated hot blast connection into the hot blast main. The hot blast main led directly to a bustle pipe surrounding the blast furnace where separate branches, composed of an elbow connected to a blow pipe, delivered the air into the furnace tuyeres. The temperature of the hot blast was governed by means of a mixing system consisting of a valve regulated 18" pipeline running from the cold blast to the hot blast main. By introducing varied amounts of cold air into the hot blast main a constant temperature of approximately 1000 degrees F. was maintained. This procedure was necessary because a stove normally heated the cold blast to temperatures higher than 1000 degrees at the beginning of its air cycle before gradually giving up its heat. When the stove could no longer heat the blast to 1000 degrees it was put back on gas. Under normal conditions, the operation of the stoves was alternated with three stoves on gas while the other was on air.[1]

Difficulties encountered with the performance of the hot blast stoves, and the installation of gas fired blowing engines associated with the addition of blast furnaces numbers five and six in 1907 prompted Duquesne Works officials to experiment with new methods of cleaning blast furnace gas. The problem centered on the fine particles of flue dust which remained entrained in the gas after it left the dust catcher. Much of this dust passed up through the stoves' combustion chambers and became lodged in their checkerwork, thus constricting the openings provided for the passage of the gas as well as the cold blast air. Over time the checkerwork openings became completely clogged, rendering the stoves incapable of absorbing heat or giving it up. As a result, each stove had to be taken off line for a period of five or six days every two months for a complete cleaning which meant that for one-third of its time in operation the blast furnaces were deprived of one-fourth of their heating surface capacity.

The decision to use four 3600 hp gas fired blowing engines, manufactured by the Snow Steam Pump Works, for the production of cold blast air at blast furnaces number five and six increased the need to provide the appropriate blast furnace plant equipment with clean gas. Because the engines required fuel gas almost completely free of entrained particulate, plant officials were faced with the prospect of furnishing them with very clean gas from the blast furnaces or buying natural gas from outside sources.

In view of the difficulties experienced in the original system of producing and delivering combustion air to the blast furnaces, plant officials in 1908, led by Ambrose N. Diehl, superintendent of the blast furnace plant, devised an experimental gas cleaning plan. An industry wide pioneering effort, the four year long experiment was set up to compare the more traditional gas cleaning approach to a newly conceived wet gas cleaning system in terms of efficiency and cost effectiveness. In both systems gas flowing from the dustcatcher at each blast furnace was directed through an additional dustcatcher per furnace before it was combined into a single 8'-6" diameter rough gas main. From the rough gas main a portion of the gas was taken directly to the boilers and hot blast stoves at blast furnaces numbers one and two while the rest of it was conducted to the newly constructed wet system.

The wet system, which was laid out linearly, consisted of nine 12'-0" diameter x 76'-0" high scrubbers arranged in parallel, four electric motor driven Sturtevant fans, each with a capacity of 84,000 cfm, and four horizontal Theisen gas washers. The scrubbers were theoretically designed to clean the gas to within one-fifth grain per cu. ft. while cooling it in order to remove most of its moisture, thus increasing its B. T. U. value. Under the experiment's original conception, gas traveling through the rough gas main leading to the wet washing system was first introduced into the bottom of one of the scrubbers. As the gas was rising up through the scrubber at a maximum rate of 30,000 cfm, it was washed by 815 gpm of water issuing downward from a rotating nozzle. The water passed through a series of screens so that it formed rain like droplets for the purpose of creating direct contact between the water and the incoming gas. Upon leaving the top of the scrubber, the gas was blown through the Sturtevant fans into the clean gas main where most of it was diverted to the boilers and hot blast stoves at blast furnaces number three, four, five and six. The remainder was taken to the Theisen washers in preparation for delivery to the gas blowing engines. Each of these washers consisted of a stationary horizontal cylinder which enclosed a smaller 150 hp motor powered revolving cylinder, on the shell of which was mounted twenty-four steel vanes. Gas was admitted at one end of the cylinders while low pressure water dashed to a spray by the revolving vanes was admitted through the outer cylinder by six pipes at the opposite end. Because the gas and the water were traveling in opposite directions they were thoroughly mixed, thus wetting the small particles of dust which therefore separated out with the water. Upon exiting the Theisens, the gas was cleaned to an average dust content of less than one-hundredth grain per cu. ft.

Slurry from the scrubbers and Theisens was drained to a settling basin located adjacent to them. The 26'-0" wide x 161'-0" long x 11'-6" deep basin (settling depth equaled 6'-0") was divided into ten sections each with equal sub-divisions representing half of the section. Slurry was deposited successively into each of the sections' sub-divisions. As the dirt and water filled up a sub-division, the water was drained through a sewer into the Monongahela River while the sludge, which was high in iron content, was loaded by a grab bucket into a railroad hopper car for delivery to a local sintering plant where it was agglomerated prior to being recharged into the top of the blast furnaces.

Early efforts to conduct the experiment were stymied by the poor performance of the gas scrubbers. This was due to the inability of the washing water to come into intimate contact with the gas rising through the scrubber because the high velocity of the ascending gas deflected the water, thereby creating a channel through which the gas escaped without being cleaned of its entrained particulate. A corrective to the problem was found by making the washing water, as opposed to the gas, the dominant element in the system by delivering the water in such a manner as to change the direction of the gas in its upward movement while at the same time spraying it repeatedly. In order to accomplish this objective, a new system of delivering the scrubber washing water was devised. It consisted of cut off valves, stationary nozzles, and an altered relationship between the nozzles and the screens.

The rotating nozzles at the top of the scrubber were replaced by two sets of seven upward pointing nozzles which were positioned across the diameter of the scrubber and inserted one above the other. Incoming water entered the scrubber through a cut off valve located at each set of nozzles and was forced upwards through two screens, placed at six foot intervals, before falling back through them in the form of droplets. The 5 hp motor driven cut off valves were composed of a series of openings or ports, one for each nozzle, which were successively blocked by a revolving core located inside of the valve. Consequently, the valves shut off the water leading to each nozzle in turn, making an area of low resistance over the temporarily dormant nozzle. As the gas was naturally directed to the area of low resistance, the water was turned on again thereby deflecting it to the next nozzle. In this manner a spiral motion was created which gave a larger exposure of the gas area to the washing water than would normally result. As such, the principle of using water to guide the passage of the gas in the scrubbers, in what became known as the Diehl spray gas washer, became one of the standard methods employed in industry-wide wet systems over the next half-century.

After four years of meticulous documentation the results of the experiment markedly favored the wet gas cleaning system. While the hot blast stoves using gas from the more traditional cleaning system continued to be taken off line every two months for cleaning, the stoves which used gas from the wet system operated continuously over the course of the experiment. Lower moisture levels in the gas emanating from the wet system resulted in higher burning efficiency when compared to the gas flowing from the more traditional system. Furthermore, when comparing the cost of constructing and maintaining the equipment used in the wet system to the cost of maintaining the hot blast stoves operating under the old system it was found that gas cleaned by the wet system saved the plant 0.1591 cents per ton of iron. An additional advantage of the wet system was that the relatively clean gas it produced allowed furnace men to decrease the openings in the checkerwork of the hot blast stoves thereby substantially increasing the total heating surface of each stove, which resulted in the production of higher hot blast temperatures. As a result, the experiment not only substantiated the value of the wet gas cleaning system for the production and delivery of combustion air at the Duquesne blast furnace plant but proved its merit for the entire industry as well.[5]

Between 1908 and the early 1940s the physical features of the combustion air and production system at Duquesne remained constant. Between 1943 and the early 1980s, however, the system became the focal point of a number of significant experiments. Moreover, the period witnessed installation of major pieces of equipment which served to both upgrade existing facilities and to modify the system.

One of the early experiments during this period concerned the efficacy of controlled steam additions to the combustion air. For many years it had been thought that a primary cause of blast furnace irregularity (i.e. differences in the chemical composition of pig iron produced in different heats) was the varying content of moisture carried by the blast air which was initially drawn from the atmosphere. As a consequence, a large number of furnace operators introduced controlled amounts of steam into the blast air as a means to regulate the amount of moisture in it. Although this practice resulted in higher coke consumption per ton of iron produced because the added moisture had a cooling effect on the furnace hearth, furnace operators, who used controlled steam additions, maintained that it resulted in better furnace regularity, more iron per heat, and a lower silicon content in the iron.

In order to test this hypothesis, L. E. Liddle, superintendent of the Duquesne blast furnace plant, experimented with the addition of steam at blast furnaces number three and four between October, 1943 and October, 1944. Alternating between periods of controlled steam additions to the cold blast main and periods of natural blast conditions, the experiment compared measurements regarding (1) coke consumption, (2) quantity of iron produced, (3) blast furnace regularity and flue dust production, and (4) iron quality. With the exception of coke consumption, all findings of the experiment contradicted conventional wisdom on the matter. During periods when steam was introduced, iron production fell by 5 percent with no significant drop in silicon levels. Nor did the introduction of steam materially affect the regularity of furnace production. Blast furnace number three, normally the most regular furnace within the blast furnace plant, remained proportionately more regular than blast furnace number four throughout the experiment. In this case the difference in regularity lay in the number of tuyeres which were constructed into each furnace -- sixteen at number three as opposed to twelve at number four. It should be noted, however, that controlled steam additions to the blast air performed an increasingly important function as hot blast temperatures approached 2000° F. after 1950. The higher temperatures created higher flame temperatures in the hearth than was necessary thereby causing the furnace to hang and operate irregularly. The controlled addition then was used to maintain an acceptable flame temperature.[6]

Important changes were made to the plant's gas cleaning operations between 1952 and 1967 beginning with the replacement of the original gas scrubbers installed in 1908. A more significance industry-wide innovation was the installation of a new ferromanganese gas cleaning system in 1953. Begun in 1949 at blast furnace number two, the production of ferromanganese generated waste gases with qualities much different than those produced in furnaces on basic iron. The temperature of the gas (750° F.), for example, was nearly double the temperature at which gas from basic iron production left the furnace. Second, after leaving the dust catcher, the quantity of fine entrained particulate (about eight grains per cubic foot) was also double that contained in the flue gas emanating from furnaces on basic iron production. Consequently, it was impossible to clean all of the gas flowing from a furnace on ferromanganese by conventional methods. This meant that much of the fume had to be emitted into the atmosphere through bleeder stacks located at the top of the furnace. Third, the floury composition of the flue dust from ferromanganese furnaces made it difficult to store as it would become air-borne in the slightest breeze. Compounding the problems associated with ferromanganese production was the pyrophoric nature of the flue dust which made it susceptible to spontaneous combustion upon exposure to the atmosphere.

Efforts to find solutions to these practical problems were further influenced by smoke control legislation passed by Allegheny County in 1949. Among the most stringent in the nation for its time, the ordinance limited flue dust emissions to .5 or less pounds per 1,000 pounds of gas produced, mandating that 85 percent of all industrial gas produced be removed.

Over the years several cleaning methods and types of equipment were tried at Duquesne without appreciable success. For example, ferromanganese gas was run through an electrical precipitator after it had passed through the plant's conventional gas cleaning equipment. This experiment lasted less than a year as the great quantity of dust generated in ferromanganese production completely clogged up the precipitator at frequent intervals. Finally, after years of research conducted by the United States Steel Corporation in conjunction with engineers from the Research Corporation at the Isabella furnace plant in Etna, Pa., a workable solution to the cleaning problem was found. It resulted in the installation of the industry's first cleaning plant devoted solely to ferromanganese gas at the Duquesne Works. The plant consisted of five parallel units, each composed of a gas conditioning tower, an electrical precipitator, a screw conveyor-fed rotary kiln, and a continuous mixer. Two additional bucket conveyor-fed intensive mixers served all five units before discharging the flue dust into a briquetting press.

The process began with the transfer of the flue gas from the furnace's dust catcher to the bottom of one of the 15'-0" diameter x 60'-0" high gas conditioning towers where three banks of water sprays cooled the gas to 350° as it rose up the tower. From the top of the tower the gas was taken by means of a 3'-6" downcomer into the top of the unit's electrical precipitator. Along the top inside portion of the precipitator, oil-immersed, tube-type rectifiers ionized the incoming gas. The charged particles in the gas were subsequently attracted to a series of electrodes composed of 3/16" square twisted steel rods which were suspended from an insulated high tension framework located just below the rectifiers. Particles which adhered to the electrodes were dropped to collecting hoppers located underneath the precipitator with the help of magnetic impulse rappers while the cleaned gas was taken out through a 5'-0" diameter discharge line leading to a clean gas manifold supplying the boilers.

The light and fluffy flue dust was released from the bottom of the collecting hopper by means of a star valve into a screw conveyor which led directly to the unit's 2'-6" diameter x 20'-0" long rotary kiln. After oxidation, the dust, which increased in bulk density from twelve to thirty pounds per cubic foot, was discharged from the kiln into a water jacketed mixer where water was added to agglomerate and cool the dust. An enclosed 18" belt conveyor took the partially wetted dust from the primary mixer to bucket elevators which supplied two large, batch-type, mix-mullers where more water was added and mulled into the dust in order to attain the proper consistency for briquetting. The 2" x 2" pillow shaped briquettes were produced by feeding the batch from the final mix-mullers through the die rolls of two briquetting presses operating under forty tons of pressure. Upon pressing, the briquettes were taken by endless chain bucket conveyors to overhead storage bins.

The installation of the ferromanganese gas cleaning system at Duquesne marked the beginning of a transition period with respect to changes and additions to the combustion air production and delivery system at the blast furnace plant. On one hand, the construction of the system allowed plant officials to make blast furnace number three ready for ferromanganese production, doubling the plant's capacity. The addition of the system, then, could be seen as constituting a continuation of the tradition whereby change was directly related to increased productivity. On the other hand, the limitations of the new gas cleaning system underscored the increasing influence which local, state, and federal lawmakers had over iron and steel manufacturing processes with regard to the implementation of community wide environmental standards. Prior to this time corporate officials authorized projects like the ferromanganese gas cleaning system only if the flue dust could be recycled into the productive system, thereby providing a return on the company's investment. Yet, even though the briquettes contained approximately 21 percent manganese, the inability of company metallurgists to discover a method by which to separate the manganese from the 12 percent alkali contained within them prohibited the productive reuse of the briquettes. As a result, then, of the negative cost-benefit character of the gas cleaning plant, ferromanganese operations at the Isabella Furnaces and Clairton Works were shut down while the Duquesne Works became the company's principal producer of ferromanganese within Allegheny County. Consequently, the expansion of ferromanganese production at Duquesne must be seen as an effort by the corporation to cut its losses.[4]

Beginning with the start-up of rebuilt blast furnace number three in 1953, plant officials embarked on a program designed to upgrade the facilities related to the production of cold blast air by installing a turbo-blower designed and manufactured by the Ingersoll-Rand Corporation. Adhering to the more traditional positive cost-benefit rationale for changes to the system, the turbo-blower replaced three of the old steam engines and was capable of delivering 90,000 cfm of air at 30 psi to the hot blast stoves associated with blast furnace number three while using 50 percent less steam. Moreover, the turbo-blower's accompanying surface condenser allowed it to recycle the condensate of the spent steam to the boiler feed water system without pre-treatment. The production and delivery of cold blast air to blast furnaces number one, two and four were modernized with the addition of another 90,000 cfm Ingersoll-Rand turbo-blower in 1954 and a 125,000 cfm Ingersoll-Rand turbo-blower, with spilt wind capabilities in 1955.[5]

County wide governmental measures to improve the quality of river water combined with improved technology for reclaiming suspended particulate in the waste water from the gas scrubbers and Theisen gas washers to provide plant managers with the incentive to add a clarifier/thickener to the gas cleaning system in 1957. Slurry from the gas scrubbers and Theisen washers were taken by pipeline to the bottom of a 90'-0" diameter x 12'-0" high clarifier manufactured by the Dorr-Oliver Company. The waste water was admitted to the top of the clarifier through its centerwell where a dosage of anionic polymers was fed into it for the purpose of aiding the flocculation of fine entrained particles. Slurry water spilled over the centerwell to the bottom of the clarifier and rose, at a rate of 2900 gpm, upwards while the suspended solids within the slurry dropped to its bottom. The treated water overflowed the side of the clarifier at a constant rate into a launderer, which was an approximately 2'-0" wide x 3'-0" deep ring encircling its outside diameter. A connecting sewer line, located at the bottom of the launderer, took the ostensibly clarified water back to the river while the sludge was pumped to the settling basins where it was removed by grab bucket after drying.[6]

Major construction projects involving blast furnaces number four and six between 1959 and 1962 significantly altered the make-up of the combustion air production and delivery system. As part of a major rebuild of blast furnace number four in 1959, new 21'-0" diameter x 121'-0" high hot blast stoves were installed by the William M. Bailey Company. The 150,428 square feet of heating capacity in each stove was by far the largest heating area among existing hot blast stoves in the blast furnace plant. This record, however, was quickly surpassed by the construction of the hot blast stoves associated with the Dorothy Six complex in 1962. Designed and installed by John Mohr and Sons Inc., each of the three 32'-0" diameter x 130'-0" high stoves contained a total heating surface of 450,781 square feet. Other important equipment relating to the combustion air production and delivery system which were part of the construction of Dorothy Six included the installation of an axial turbo-blower, a new gas cleaning apparatus, and a continuous process for dewatering blast furnace sludge.

The axial turbo-blower, designed and built by the Elliott Company of Jeannette, Pennsylvania, had the capability of delivering 155,000 cfm of air at 55 psi to Dorothy Six. The first axial machine in the United States to go into service in the active production of iron, the adjustable blades at the compressor end of the turbo-blower allowed for the delivery of different volumes of air to the furnace. This made it possible to produce, in a controlled manner, different types of pig iron.

The gas cleaning equipment at Dorothy Six, consisting of a dust catcher, a 190,000 scfm venturi type primary gas washer and a 190,000 scfm gas cooling tower linked together in series. It represented a first step away from the plant's traditionally centralized gas cleaning operation. Gas flowing from the top of the furnace was first passed through the dust catcher where the large entrained particulate were removed from it in the usual manner before it was taken to the top of the venturi type primary gas washer. The gas washer consisted of a venturi shaped unit connected to a 21'-0" diameter x 49'-6" high tile lined hollow cylinder. Gas entering the top of the venturi unit was forced through its narrow throat where it was sprayed at a rate of 2400 gpm with water by low and high pressure nozzles set at different angles. Upon spraying, the gas, containing .01 grains of flue dust per cubic foot, was led out of the washer through a 84" i.d. connection located near the top of the cylindrical structure set below the venturi unit to the gas cooling tower.

Entering near the bottom of the 24'-0" diameter x 100'-0" high cooling tower, the washed gas was cooled by a series of water sprays as it rose up the tower. The cooled gas subsequently left the top of the cooling tower through the 96" i.d. clean gas main leading back to the burner connection on the hot blast stoves. The slurry from the gas washer and gas cooler dropped to the cone at the bottom of each piece of equipment and was taken out by means of a pipeline to the clarifier or thickener where it was joined by the wastewater flowing from what remained of the centralized system.

After passing through the clarifier in the usual manner, the separated particulate or sludge was pumped over to a continuous mechanical dewatering process located in the newly constructed filter cake house near the clarifier. Taking the place of the settling basins and located on the upper floor of the filter cake house, the equipment making up the process included two 2 hp motor driven filter cake machines, each composed of six equally spaced 8'-10" diameter cloth covered vacuum disc filters set inside of an approximately 12'-0" long bifurcated tub consisting of a slurry side and a discharge side. The process embodied three stages -- forming, drying, and discharge. During the forming stage, the discs were passed, under vacuum, through the slurry. As they passed, cake was built up and water was removed by filtration through the cloth. As the discs emerged from the slurry, they were dried by air drawn through the cake by the applied vacuum. At the end of the cycle, compressed air was admitted into the discs thereby expanding the cloth as it was passed over a knife edge which discharged the dried particulate through a chute leading to a dumping area directly below.[7]

The gas cleaning system was upgraded further when the Diehl gas scrubbers were replaced by two new systems at blast furnaces number three and four in 1971. Designed to clean blast furnace gas from the aforementioned furnaces as well as from blast furnace number one, the equipment included a dust catcher, a venturi scrubber, and a gas cooling tower connected in series. In order to save water, the new system recycled water from the gas cooling tower into the venturi scrubber. Spray water from the gas cooler was diverted by means of a "chinese hat" located inside of it to a stand pipe before it was pumped over to the scrubber where it was sprayed on the gas coming from the dust catcher at a rate of 150,000 cfm. Both the gas and the slurry left the scrubber by means of a flooded elbow leading to the gas cooling tower. The gas rose up the tower and was sprayed, cooling it to a temperature of 112° F, while the slurry dropped to its cone before being pumped over to the clarifier.[8]

The principle of recirculating water used in blast furnace gas cleaning systems gained increasing importance in the 1970s because of federally sponsored clean water legislation and the creation of the Environmental Protection Agency. As a result of a negotiated agreement between the E.P.A. and the United States Steel Corporation in the late 1970s, the combustion air production and delivery system at the Duquesne blast furnace plant underwent significant changes. The crux of the settlement centered on controlling the amounts of suspended solids, cyanide, ammonia, and phenol discharged daily from the corporation's gas cleaning facilities. In an ill fated effort to accomplish this objective, a water quality control system was installed at the Duquesne plant in 1979. The evaporative system, as it came to be known, consisted of a new clarifier, a hot well, a six unit cooling tower, and a cold well. There were also a number of chemical feed stations located throughout the gas cleaning and water treatment systems.

A total of 14,500 gpm of wastewater from the gas cleaning processes at blast furnaces number three, four, and six was recirculated through the system. Water entering the hot well came from two sources, the clarifier and the relatively clean water coming from the gas cooling towers. After being pumped from the hot well, the water passed through an in-line strainer and a chemical treatment station before it proceeded to the cells of the water cooling tower. Near the top of the tower, the water flowed through a low pressure spray distribution system vertically downwards into a basin while air was induced up through each of the cylindrical ceramic cells by a large fan located at the top of each cell. In this manner, the clarified water was cooled from 114° F to 90° F. As the water entered the basin at the bottom of the cooling tower, it was treated with chemicals before being admitted to the cold well through sluice gates where it was subsequently pumped over to the on-site gas cleaning systems.

Chemical additions were a key component in the process because the suspended solids, like iron oxide and lime dust, and the soluble compounds which were removed from the blast furnace gas tended to build up in the wastewater on each pass through the recirculating system. One reason for the increasing concentration of dissolved compounds in the system was the evaporation of pure water passing through the cooling tower. The compounds which had been contained in the water vapor were consequently left behind in the system. In addition to the effect of evaporation, more soluble calcium salts were introduced into the water on each pass, thus increasing the build up further. If left unchecked the calcium salts built up to such a point that the water no longer held them in solution. As a result, they precipitated into hard water mineral scale which effected a plugging of system pipes and spray nozzles. Furthermore, there developed a tendency in the system for microbiological organisms to accumulate, which in their natural life cycle reproduced and caused foul and slimy masses to build up in the system. In an effort to allay the possibility of blockage, a variety of chemicals were introduced at the clarifier, hot well, cold well, and the gas cleaning facilities at blast furnaces number three, four, and six. These included sulfuric or hydrochloric acid and/or dispersant for mineral scale, polymers and surfactant for suspended solids, and biocides for slime. Despite the addition of these chemicals, the prevalence of mineral scale, suspended solids, and slime due in part to the evaporation of water at the cooling towers forced plant managers to blowdown up to 1470 gpm of wastewater into either the slag pits at blast furnaces number one and six or the river. A corresponding amount of make-up water had to be drawn into the system from the river.

Although the E.P.A. allowed plant operatives to blowdown as much as 1470 gpm of wastewater upon start-up of the water treatment system, progressively stricter guidelines required that blowdown values not exceed 610 gpm. Given the problems regarding the increasing concentration of system plugging substances due to the evaporation of water at the cooling tower, it became increasingly difficult to meet the more stringent blowdown guidelines. Moreover, as water passing over the cooling tower evaporated, it emitted levels of carbon monoxide into the atmosphere which exceeded E.P.A. standards. As a result of both of these factors, plant officials shut down the evaporative system after only one year of operation as part of ongoing negotiations with the E.P.A. The talks culminated in a settlement whereby the company agreed to retire blast furnaces numbers one and three and build a new non-evaporative recycle water treatment system for Dorothy Six. Built in 1980, the non-evaporative system was designed to treat 4800 gpm of process water. It was composed of a gas washer hot well, a gas cooler hot well, a spray well, two shell and tube type heat exchangers, and associated chemical feed equipment.

The key components of the new system were the spray well and heat exchangers. Instead of running the process water through spray nozzles, thus exposing it to the evaporative effect of the atmosphere, gas washer and gas cooler water was passed from their respective hot wells through the heat exchanger tubes which were in turn sprayed by water from the spray well. The process water was then pumped over to the gas washer and gas cooling tower directly from the heat exchangers. In this manner, the process water was cooled from a temperature of 125° F to 90° F. while blowdown rates were kept as close to zero as possible.[9]

The combustion air and delivery system at the Duquesne blast furnace plant began as a relatively simple operation. Early additions and changes to the system were primarily aimed at increasing production and efficiency. These changes centered on the introduction and subsequent improvements of the plant's wet gas cleaning systems, the improvement of its cold blast production and delivery equipment, and improvements in hot blast stove construction. Beginning with the addition of the ferromanganese gas cleaning plant in 1953 and running through the installation of the various water treatment facilities, however, innovations to the system were increasingly driven by government imposed environmental protection policies rather than by traditional productivity concerns. During the five years preceding the shutdown of the blast furnace plant in 1984, millions of dollars were spent to change the combustion air and delivery system as a result of this latter category.

ENDNOTES:

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8.United States Steel Corporation, "Location Plan - Gas Cleaning Facilities - #3 & #4 Blast Furnace - Blast Furnace Area: Drawing #56675, February 21, 1969."; U. S. Steel, "Mon Valley Works - Duquesne Plant Property Inventory List," (Duquesne, 1984): 68; Operation Manual, Project No. 536-4366, "W. Q. C. Facilities - Blast Furnace Recycle System," (Duquesne, 1979): 2-4 - 2-6; "Engineering Flow - P & I Diagram - Fume Cleaning System for Blast Furnaces No. 3 & 4: Drawing #56850, March 19, 1969."

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<u>Historic Name</u>: U.S.S. Corporation, Duquesne Works, Blast Furnace Plant, Raw Materials Handling and Storage System.
<u>Present Name</u>: U.S.X. Corporation, National-Duquesne Works, Blast Furnace Plant, Raw Materials Handling and Storage System.
<u>Location</u>: Upper Works
<u>Construction</u>: 1896, 1901, 1918 - 1928, 1954 - 1962
<u>Documentation</u>: Photographs of the Blast Furnace Plant can be found in HAER No. PA-115-A.

DESCRIPTION

I. <u>Rotary Car Dumper</u>:

A. <u>Rotary Car Dumper Building</u>: The rotary dumper building was designed by the Heyl and Patterson Company and built by the American Bridge Company. It is located south of blast furnace number six near the shoreline of the Monongahela River. Laid out on a north-south axis, it is 40'-6" wide x 72'-1" long x 17'-8 5/8" high. The steel framed structure of the building is covered by corrugated metal. The building's gable roof is supported by Fink trusswork. An approximately 27'-0" wide opening in the floor runs the length of the building in order to accommodate the rotary car dumper. Located at the northwest corner of the building is a 10'-0" square x 9'-0" high operator's room. At the northeast corner of the building is an approximately 9'-0" wide x 10'-0" long x 9'-0" high motor control room.
Construction Date: 1957.

B. <u>Rotary Car Dumper</u>: The 26'-0" diameter x 60'-0" long steel framed rotary car dumper, designed and built by the Heyl and Patterson Company of Pittsburgh, PA, is laid out on a north-south axis. The centerline of the car dumper is located 22'-2" off the east wall of the building. Its southern end coincides with the south wall of the building. Each end of the car dumper is made up of a braced steel column-like shape formed into a 26'-0" diameter ring sitting above and below the floor line of the building. The outside flange of each ring supports one of the car dumper's two drive chains and a steel rail around its circumference. Each rail rests on two sets of 12" diameter sill wheels. The sill wheel sets are composed of two steel rail wheels which are secured by clevis connections to a large steel column, laid out on a east-west axis, located directly below each ring. The columns, which are supported by concrete footers located in the basement of the building, support the sill wheels near its eastern and western ends.

The inside flange of each ring forms the parameters of an

11'-9" wide x approximately 20'-0" high arched opening at its center, extending 2'-3 1/8" below the floor line of the building. The opening facilitates the installation of the car dumper's platen and accommodates the entry and exit of railroad hopper cars. The base of the opening in each ring supports the platen. The platen consists of two large steel columns, spaced 4'-8 1/2" apart, which support a set of standard gauge railroad tracks located on top of a 11'-9" wide x 60'-0" long x 2" thick platform set at the building floor level. Laid out on a north-south axis about the centerline of the car dumper, the platen is hooked at its supporting steel columns to a drive shaft extending along the centerline of the structure. Between the platen tracks and located at each rail are the platen retarders. The retarders are pneumatically operated steel shoes which clamp onto the wheels of a railroad hopper car just prior to its rotation.

A set of four linearly designed clamp beam and double post assemblies, used for securing the top of hopper cars to the car dumper, form a bridge across the platen tracks. The posts in each assembly are spaced 12'-0" apart about the centerline of the tracks. The distance between the clamp beams is 10'-0" with the outside clamp beams located 15'-0" respectively from the car dumpers northern and southern ring. Each assembly consists of a 1'-0" wide x 12'-0" long x 2'-9 1/2" steel plate constructed movable clamp beam spanning a pair of steel columns located, one each, on the eastern or western side of the platen. Each column in the assembly is equipped with a roller wheel attachment which rides up and down fixed columns by means of an interconnecting wire rope and sheave wheel arrangement. On the eastern side of the platen the fixed columns are part of the supporting steel framework welded to each ring and the platen. The fixed columns on the western side of the platen are encased in the spill truss which is welded to each ring of the dumper. The steel plate constructed spill truss is 1'-6" wide x 60'-0" long x 14'-0" high. It is used to support the side of a hopper car as it is being rotated.

The dumper is powered by a 40/80 hp Westinghouse Induction Motor running at 1400/700 rpm. The motor is connected to a size 180 Jones-Herringbone Speed Reducer with a ratio of 13.3-1. A 6" diameter line shaft runs through the speed reducer to the north and south ends of the dumper where it connects into a Link Belt pinion gear drive run in an oil bath which turns a chain drive wrapped around each ring of the dumper thereby rotating the structure.

Located above and running the entire length of the car dumper is a system of water sprays which are used to clear the air of dust after the contents of the hopper cars have been

dumped.
Construction Date: 1957.

C. Fifty Ton Hoppers: The tops of three 50-ton inverted pyramid shaped hoppers are welded to each other and to a steel framework located 10'-10 1/2" below the floor of the building. Aligned linearly along a north-south axis, the centerline of the hoppers is located 4'-3" west of the centerline of the tracks. The centerline of the northern most hopper is located 14'-2" from the northern inside wall of the basement. The opening at the top of the hoppers is 18'-6" square. The opening at the bottom of the hoppers is 6'-10 3/8" square. The inside walls of the hoppers are lined with ceramic tiles.
Construction Date: 1957.

D. Vibrating Feeders: Iron ore passing through each hopper is deposited onto a vibrating feeder, manufactured by the General Kinematics Corporation, which is attached to the bottom of the hopper. Each feeder is a 9'-5" long x 9'-0" wide x 2'-5 1/2" deep steel plate constructed trough, and is connected to four air cylinders which are anchored to each hopper by a 7/8" diameter wire rope. As such, the feeders have the capability of opening or closing the trap door at the bottom of the hoppers. A 10 hp motor powered conveyor belt is provided inside of the trough. The belt drops the ore onto conveyor belt number one.
Installation Date: 1970.

E. Conveyor Belts Number 1, 2, 3, & 4: Conveyor belts number 1, 2, 3, & 4 are interconnected and run in a south to north direction alongside the trestle from the Car Dumper Building to the northern edge of the ore yard. The belts travel a distance of 2755'-2 1/2". They are distinguished by their individual motor power and drive stations.
Installation Date: 1957.

1. Conveyor Belt Number One: Manufactured by the U.S. Rubber Company, conveyor belt number one rests on a steel frame 3'-9" above the basement floor of the car dumper building. The centerline of the belt is 6'-8 11/16" west of the centerline of the 50-ton hoppers. The belt is 48" wide, 15/32" thick, and 74'-1" long. It runs at a speed of 550 feet per minute and has a capacity of 3500 tons per hour at 135 pounds per cubic feet of ore. Located at the northern end of the conveyor belt is its motor, gear reducer, and drive shaft assembly. The motor is a 60 hp Westinghouse A.C. motor which runs at 1500 rpm. The Jones-Herringbone gear reducer has a ratio of 24.1 to 1.

2. Conveyor Belt Number Two: Manufactured by the U.S. Rubber Company, conveyor belt number two rises from the end of

conveyor belt number one through a 7'-0" square concrete tunnel for a distance of 59'-0" at an angle of 12 degrees. The belt is 48" wide, 15/32" thick and 283'-9 3/8" long. It runs at a speed of 550 feet per minute and has a capacity of 3500 tons per hour at 135 pounds per cubic feet of ore. Located at the northern end of the conveyor belt is its motor, gear reducer, and drive shaft assembly. The motor is a 30 hp Westinghouse A.C. motor which runs at 1500 rpm. The Jones-Herringbone gear reducer has a ratio of 23.6 to 1.

3. Conveyor Belt Number Three: Extending from the northern end of conveyor belt number two, conveyor belt number three rests on a steel frame approximately 3'-0" above the trestle. The belt is 48" wide, 5/16" thick, and 1261'-4 3/4" long. It was manufactured by the U.S. Rubber Company and runs at a speed of 550 feet per minute with a capacity of 3500 tons per hour at 135 pounds per cubic feet of ore. Located at the northern end of the conveyor belt, along the western wall of the stockhouse is its motor, gear reducer, and drive shaft assembly. The motor is a 500 hp Westinghouse A.C. motor which runs at 1200 rpm. The Philadelphia gear reducer has a ratio of 30 to 1.

4. Conveyor Belt Number Four: Conveyor belt number four rests on a steel frame approximately 3'-0" above the trestle and extends from the northern end of conveyor belt number three. The belt was manufactured by the U.S. Rubber Company. It is 48" wide, 5/16" thick, and 1135'-11 3/8" long. It runs at a speed of 550 feet per minute and has a capacity of 3500 tons per hour at 135 pounds per cubic feet of ore. The belt ends at a drive house which is located at the northern end of the ore yard. Inside of the drive house is the belt's motor, gear reducer and drive shaft assembly. The motor is a 300 hp Westinghouse A.C. motor which runs at 1200 rpm. The Jones-Herringbone gear reducer has a ratio of 24.1 to 1.

5. Drive House for Conveyor Belt Number Four: The drive house, built by the American Bridge Company, is a 14'-0" wide x 27'-6" long x 24'-0" high steel framed building with a stainless steel sheeting exterior. Its stainless steel exterior gable roof is supported by King Post trusswork. Welded to the trusswork along its centerline and extending the entire length of the building is a geared monorail for a 5-ton chain hoist.

Construction Date: 1957.

F. Tripper Number One: Manufactured by the Link Belt Company, tripper number one diverts ore traveling on conveyor belt number three into either the ore yard or into ore bins hung from the trestle above the stockhouse by means of a feeder conveyor and chutes. Each feeder conveyor is powered by one of two 30 hp

Westinghouse D.C. motors running at 1750 rpm. Each motor is connected to a Philadelphia gear reducer with a ratio of 20.9 to 1. The tripper is 9'-0" wide x 32'-4" long x 16'-10 1/8" long and travels on railroad tracks, spaced 7'-5" apart, which straddle conveyor belt number three. It travels a length of 499'-9" and is powered by an electric rail.

Installation Date: 1957.

G. Tripper Number Two: Manufactured by the Link Belt Company, tripper number two is the same size and performs the same function as tripper number one. It travels a length of 988'-10 1/2".

Installation Date: 1957.

II. Trestle:

A. Flux and Sinter Fines Track System: Located just east of an elevated 3'-0" walkway which separates the car dumper conveyor belt system from the trestle is the flux (i.e. limestone and dolomite) and sinter fines track system. The system begins south of blast furnace number six and consists of two sets of standard gauge tracks running side by side at blast furnace number six before merging into a single set of tracks at blast furnace number four. From there the track runs north past blast furnace number one. The tracks run directly over the stockhouse flux and sinter fines bins and have grated openings between each set of tracks which allow railroad hopper cars to dump their contents into the bins. The track system is approximately 1800'-0" long.

Construction Date: 1962.

B. Coke Track System: The coke track system is located 5'-11 1/4" above, and approximately 10'-0" east of the flux track system on a platform supported by steel columns. The system begins south of blast furnace number six and consists of two sets of standard gauge tracks running side by side in a northerly direction past blast furnace number one. The tracks run directly over the stockhouse coke bins and have grated openings between the tracks at each coke bin thereby allowing railroad hopper cars to dump their contents into the bins. The track system is approximately 1800'-0" long.

Construction Date: 1919-1924.

C. Car Puller Systems: There are five car puller systems associated with the trestle. The car pullers are used to tow railroad hopper cars onto one of the trestle track systems in order to facilitate the stocking of bins.

1. Car Puller Number One: Car puller number one serves the stockhouse bins associated with blast furnaces number one and

two. It is powered by a 20 hp, 1750 rpm Sterling A.C. motor connected to a Falk gear drive which is attached to a 18" diameter winch drum wrapped with a 7/8" diameter steel cable. The motor, drive, and winch drum assembly is located on a 10'-5 3/4" wide x 11'-8" long steel column supported platform 11'-6" below the coke track system and 103'-6" north of the centerline of blast furnace number two. The cable extends from the winch drum in a northerly direction for a distance of 33'-6" where it wraps around a 2'-6" diameter steel column supported sheave wheel before rising vertically at a slight incline for a distance of 7'-2 1/2" where it rides over, under, and between two 2'-6" diameter steel column supported sheave wheels upwards onto the coke trestle platform. Attached to the end of the cable is a large "C" hook which latches onto the hopper cars. The capacity of the car puller is 40 feet per minute.

Construction Date: 1964.

2. Car Puller Number Two: Car puller number two serves the stockhouse bins associated with blast furnaces number three and four. Its motor, drive, winch drum, and pulley assembly operated in the same manner as car puller number one with the exception that the Sterling A.C. motor is smaller (10 hp @ 1800 rpm) and the gear drive is manufactured by the Stephen-Adamson Manufacturing Company.

Construction Date: 1960.

3. Car Puller Number Three: Car puller number three, designed by the Stephens-Adamson Manufacturing Company, is a 10,000 pound continuous reversible wire rope and car puller machine. It served the stockhouse coke bins associated with blast furnace number six. The system is powered by a small motor running at 1760 rpm connected to a Stephens-Adamson gear drive which is attached to two 18" diameter winch drums straddling the motor on a east-west axis. The motor, drive, and winch drum assembly is located on a steel column supported platform approximately 3'-0" below, and in between the east and west coke tracks, 161'-4 1/2" north of blast furnace number six. A 7/8" diameter cable extending from the western winch drum travels around eight 27" diameter sheave wheels laid out in a 278'-0" long x 25'-3" wide rectangle which surrounds the east and west coke tracks before returning to the winch drum located on the east side of the motor. Attached to the taut steel cable rectangle near the southern end of its eastern border and near the northern end of its western border is a sling assembly equipped with a "C" hook which is used to tow the railroad hopper cars onto the east and west coke tracks. The capacity of the car puller is 40 feet per minute.

Construction Date: 1962.

4. Car Pullers Number Four and Five: Car pullers number four and five, designed by the Stephens-Adamson Manufacturing Company, are also 10,000 pounds continuous reversible wire rope and car puller machines. It served the north and south stockhouse sinter fines bins at blast furnace number six. The south stockhouse's power equipment is arranged and driven in much the same manner as car puller number three except that the motor, drive, and winch drum assembly is laid out on a north-south, rather than east-west axis. The motor, gear drive, and winch drums sit on top of a steel column supported platform approximately 4'-0" above grade and are located 21'-0" east of the sinter fines bins centerline, 107'-6" south of the centerline of blast furnace number six. The system is connected by two 7/8" diameter steel cables. The cable which is wrapped around the winch drum south of the motor and gear drive provides an anchor for the system. It is tied to a steel frame located 12'-0" directly south of the winch drum. The cable which is wrapped around the winch drum north of the motor and gear drive travels around nine 24" diameter sheave wheels laid out in a 207'-0" long x 30'-0" wide rectangle which surrounds the east and west sinter fines tracks and before returning to the winch drum. Attached to the taut steel cable rectangle near the southern end of its eastern border and near the northern end of its western border is a sling assembly equipped with a "C" hook which is used to tow the railroad hopper cars onto the east and west sinter fines tracks. Car puller number five, located in the north stockhouse, is a mirror image of car puller number four.

Construction Date: 1962.

III. Ore Yard:

A. Ore Yard: The 226'-0" wide x 1653'-0" long x 26'-0" deep rectangularly shaped ore yard is laid out on a north-south axis to the west of blast furnaces number one through six. It is doglegged by 3 degrees for a distance of 544'-0" on its southern end. The ore yard wall, which encompasses its north, east, and west sides is constructed of rough faced ashlar. The eastern wall is 7'-9" higher than the western wall. Along the top of the east and west ore yard walls are rails for the ore bridges to travel on.

Construction Date: 1895 - 1897.

IV. Ore Bridge:

A. Ore Bridge Number Three: Ore bridge number three was designed and built by the Heyl and Patterson Company in 1954 and is laid out on an east-west axis across the ore yard. Made out of riveted construction, it consists of a pier and shear leg which carry a 333'-0" long x 20'-0" wide Warren bridge span. The height of the span is 26'-0" from the pier leg end of the bridge for a distance of 126'-10" before becoming 24'-0" for its remaining length. The pier legs are made up of inverted pyramidal shaped steel framed trusses and are located, one each, on the north and south sides of the western end of the ore bridge. The base of each inverted pyramid is 54'-0" long x 2'-0" wide. Each leg rises at an approximate 60 degree angle from a bolted connection on top of its respective 8-wheel pier truck for a distance of 73'-0" where it is riveted to a steel frame which runs flush underneath the top chord of the bridge span. The 8 wheel pier trucks provide motive power for the pier leg end of the bridge. Each is 39'-2" long x 4'-6" wide x 7'-9 7/8" high and is constructed of four linearly designed sets of two steel rail wheels which are connected to a connecting rod arrangement that is powered and driven by a motor and gear drive assembly. The motor, manufactured by Crocker-Wheeler Company, is a 65 hp mill type D.C. motor running at 440 rpm. The Michigan Tool Company worm and gear set has a ratio of 25 to 1. Covering the motor and gear drive assembly is a 28'-0" long x 4'-6" wide x 4'-5" enclosure constructed of an irregularly shaped steel I-beam frame with a 1 1/4" thick steel plate welded to its top. A clevis for bolting the apex of each inverted pyramidal leg to the 8-wheel truck is located on the east and west side of the truck about its centerline.

The centerline of the shear legs is located 226'-0" east of the centerline of the pier legs. They are made up of inverted pyramidal shaped steel framed trusses and are located, one each, on the north and south side of the eastern end of the ore bridge. The base of each inverted pyramid is approximately 4'-0" square. Each leg rises at a approximate 60 degree angle from a bolted connection on top of its respective 8-wheel shear truck for a distance of approximately 60'-0" where it is riveted to a steel frame which runs flush underneath the top chord of the bridge span. The 8-wheel shear trucks, which provide the motive power for the shear leg end of the bridge, are constructed, powered, and driven in much the same manner as the 8-wheel pier trucks.

Located 3'-8 1/4" west of the centerline of the pier leg rail and running the length of the ore yard is a set of electric rails spaced 13 1/2" apart. Bus work from the ore bridge connecting to the rails provides the electrical energy needed to power the ore bridge man trolley and dumping system.

1. <u>Man Trolley</u>: The man trolley sits on top of a set of steel rails which run nearly the entire length of the bridge span. The rails, spaced 11'-6" apart about the span's centerline, are carried by I-beams welded to the east and west members of the span's bottom chord. The trolley is constructed

of a front and rear 30" diameter rail wheel and axle assembly from which the carriage's steel framed platform is hung. The distance between front and rear wheels is 28'-0". The platform is 9'-6" wide x 37'-9" long x 2'-0" deep. Along the centerline of the platform, located approximately 7'-0" from its west end and 2'-6" from its east end are each of the trolley's two Crocker Wheeler 75 hp travel motors running at 475 rpm with accompanying Falk gear drives and Cutler Hammer brake assemblies. Set between the travel motors are two Crocker Wheeler 200 hp hoist motors running at 380 rpm with their accompanying Falk gear drive and 36" diameter winch drum assemblies. A 1 1/8" diameter rope, wrapped around each of the winch drums, is connected to a 15-ton Blaw Knox bucket scoop. The bucket is capable of traveling horizontally for a distance of 279'-0" at a maximum trolley speed of 600 feet per minute. The hoisting speed of the motor, drive, and winch drum assembly is 200 feet per minute.

2. Repair Hoist: The repair hoist for the equipment on the man trolley is located on a monorail which is riveted to the underside of the structural steel bracing at the top chords of the bridge span, 24'-0" above the trolley's platform. Attached to the monorail, which runs the entire length of the span, is a Wright-Speedway hoist crane with a capacity of 15,000 pounds.

3. Control House and Operators Cab: A 15'-0" wide x 16'-0" long x 10'-0" high control house is suspended from the western end of the trolley carriage. It sits on a platform which is suspended from the northern and southern side of the trolley platform. The steel framed sheet steel exterior building houses electrical switch gear. The 6'-6" wide x 7'-2" long x 7'-11" high sheet steel exterior operator's cab for the man trolley is hung from the control house about the centerline of the bridge span. It sits on the eastern edge of a 12'-6" wide x 14'-0" platform which is hung from the control house platform.

4. Trolley Walkway: Made of steel grating, the 4'-0" wide walkway is wedged between and welded to the bottom chords of the bridge span and the trolley rail chords on all four sides of the structure.

5. Trolley Rail Buffer Assembly: The trolley buffer assembly consists of a 30" diameter hydraulic cylinder equipped with a piston rod capable of delivering a 3'-8" stroke which is mechanically connected to stoppers at each corner of the trolley runway. Each buffer assembly, which carries an estimated capacity of 15 gallons of Gulf # 501 oil, is designed to absorb the shock of the trolley as its reaches the end of its run.

6. Dumper: The dumper is composed of a 50-ton hopper

equipped with a heater and power operated gates. It is located on a 30'-0" square platform attached to the ore bridge on its eastern end by a steel framework extending downward from the top chord of the bridge span. The dumper, which delivers ore to the stockhouse bins, is centered over the ore bins along the trestle as it travels the length of the ore yard.

7. Anemometer Platform and Frame: The anemometer platform is approximately 7'-0" wide. It spans the northern and southern top chords of the bridge span approximately 75'-0" from its pier leg end. At the center of the platform are two 4'-0" high triangular frames made up of steel bars which are spaced 10'-0" apart about the centerline of the span. The frames were used to support an anemometer which measured wind force and speed.

8. Ore Bridge Stairwells and Landings: Steel framed stairwells and landings leading from the ground to the top of the ore bridge span are located at the pier leg and shear leg ends of the bridge.

B. Ore Bridge Number Four: Ore bridge number four was designed and built by the American Bridge Company in 1962. It is located south of ore bridge number three and laid out on a east-west axis across the ore yard. Made out of riveted steel construction, it consists of a set of pier and shear legs which carry a 334'-3" long x 24'-0" wide Warren bridge span. The height of the span is 29'-0" from the western or pier leg end of the bridge for a distance of 108'-4 1/2" before becoming 26'-0" for its remaining length. The northern and southern members of the span's top and bottom chord are laid out on a east-west axis. The eastern and western members of the top and bottom chord are laid out on a north-south axis.

The 80'-6" high pier leg is a three dimensional V shaped structure made up of large steel column framing. The V shaped legs of the structure are located on the northern and southern side of the ore bridge at its western end. Each V leg rises at a 60 degree angle from the structure's 60'-0" long bottom chord to its 34'-0" long top chords. The top chords of the structure, spaced approximately 40'-0" apart, run on a north-south axis flush underneath the northern and southern members of the span's top chord. The bottom chord of the structure runs on a north - south axis just above the 8-wheel pier trucks. A pair of 10 1/4" diameter clevis connections are hung, one each, from the eastern and western side of the bottom chord at both of its ends. The centerline of the clevis connections coincide with the centerline of the pier trucks. The two approximately 40'-0" long x 3'-0" wide x 8'-0" high 8-wheel trucks are constructed of four linearly designed sets of two steel rail wheels, laid out on a north -

south axis, which are attached to a connecting rod arrangement that is powered and driven by a 50 hp Westinghouse motor and gear drive assembly. Covering the motor and gear drive assembly on each truck is an approximately 28'-0" long x 4'-6" wide x 4'-6" high enclosure constructed of 1 1/4" thick steel plate. A pair of 10 1/4" diameter welded clevis connections are hung from the base of each cover, one each, on its eastern and western side about the centerline of each truck. A 10" diameter bolt connects the pier leg to each 8-wheel truck.

The shear leg is located 226'-0" east of the pier leg. It consists of four large steel columns riveted together into a 66'-9 1/2" high trapezoidal shape laid out on a north-south axis. The 34'-0" long top chord of the trapezoid is screwed on to a 2'-0" wide x 24'-0" long x 8'-2" high steel bar which runs flush underneath the northern and southern members of the top chord of the bridge span. The 60'-0" bottom chord of the trapezoid is bolted to each of two 8-wheel shear trucks in the same manner as the pier leg is bolted to the pier trucks. The shear trucks are constructed, powered, and driven in the same manner as the pier trucks.

Located 3'-8 1/4" west of the centerline of the pier leg rail and running the length of the ore yard is a set of electric rails spaced 13 1/2 " apart. Bus work from the ore bridge connecting to the rails provides the electrical energy needed to power the ore bridge, its man trolley, and its dumping system.

1. <u>Man Trolley</u>: The man trolley sits on top of a set of steel rails which run nearly the entire length of the bridge. The rails, spaced 12'-0" apart about the span's centerline, are carried by I-beams welded to the east and west members of the span's bottom chord. The trolley is constructed of a front and rear 27" diameter rail wheel and axle assembly from which its 11'-2 1/2" wide x 34'-3 1/2" long x 2'-9 1/2" high steel framed platform is hung. The distance between the front and rear wheels is 27'-6". The trolley's two drive assemblies are located 4'-10 5/8" from the west end and 1'-10 7/8" from the east end of the platform. Each assembly is composed of a 75 hp, 515 rpm Westinghouse D.C. travel motor connected to a Falk gear drive and a Cutler-Hammer brake which is utilized to stop the front or rear wheel and axle assembly. Set between the trolley drive assemblies are two hoist drive assemblies. Located 6"-7 3/4" from the centerline of the bucket scoop on either its western or eastern side, each hoist drive is composed of a 150 hp Westinghouse D.C. hoist motor running at 460 rpm with an accompanying interconnected Falk gear drive and 37 1/2 " diameter winch drum. Two 1 1/8" diameter ropes, wrapped around each of the winch drums, are connected to a 15-ton Blaw-Knox bucket

scoop. The bucket is capable of traveling horizontally for a distance of 282'-0" at a maximum speed of 765 feet per minute. The speed of the hoist drive assembly is 300 feet per minute.

2. Repair Hoist: The 7 1/2-ton Wright-Speedway repair hoist for the equipment on the man trolley hangs from a monorail which is riveted to the underside of the structural steel bracing at the top chords of the bridge span, approximately 24'-0" above the trolley's platform. Running the entire length of the span, the monorail is located on its centerline.

3. Control House and Operators Cab: A 13'-0" wide x 16'-0" long x 10'-0" high control house is hung from the western end of the trolley platform. It sits on a platform which is hung from the northern and southern side of the trolley platform. The steel framed sheet steel clad building houses electrical switch gear. An approximately 6'-6" wide x 7'-0" long x 8'-0" high sheet steel clad man-trolley operator's cab is suspended from the control house about the centerline of the bridge span. It sits on a platform which is hung from the western end of the control house platform.

4. Trolley Walkway: The 4'-0" wide trolley walkway, made of steel grating, is wedged between, and welded to, the bottom chords of the bridge span and the trolley rail chords on all four sides of the structure.

5. Trolley Rail Buffer Assembly: Located at each corner of the trolley runway, the trolley rail buffer assembly consists of a 30" diameter hydraulic cylinder equipped with a piston rod, capable of delivering a 72" stroke, which is mechanically connected to runway stoppers. Each buffer assembly is designed to absorb the shock of the trolley as it reaches the end of its run.

6. Dumper: Composed of a 50-ton hopper which is equipped with a heater and power operated gates, the dumper is located on a cantilevered platform at the eastern end of the bridge. The approximately 30'-0" square platform extends eastward from the shear leg. The dumper, which drops ore into stockhouse bins suspended from the trestle's steelwork, travels the length of the ore yard.

7. Motor-Generator Control House: The approximately 15'-0" wide x 30'-0" long x 19'-0" high steel framed motor-generator control house has a corrugated metal exterior and gable roof. It sits on a platform supported by the top chords of the bridge span and is located directly over the top chords of the shear leg. A motor-generator set is located on the floor of the building 7'-9"

off of its northern wall. The set, which converts A.C. current into D.C. current, consists of a 700 hp Westinghouse synchronous A.C. motor running at 1200 rpm connected to and flanked by a pair of direct current generators on its eastern and western side. The generators on the eastern and near western side of the motor are each 250 kw Westinghouse Type SK D.C. Generators running at 1200 rpm. On the far western side of the motor is a 40 kw Westinghouse Life Line D.C. Generator running at 1200 rpm. A 5-ton Wright-Speedway repair hoist rides on a monorail located directly over the motor-generator set.

Located along the southern wall at the center of the building is a main control panel manufactured by the Square D Company. The panel measures and controls each of the ore bridge's functions. Just east of the main control panel along the southern wall of the building are a Westinghouse Ampguard Control Panel, a Westinghouse Type DT-3 Power Center Transformer, and a Westinghouse Type DB Air Circuit Breaker. Located along the eastern wall at the center of the building is the motor-generator set's lubrication system, manufactured by the John Wood Company of Conshohocken, PA.

8. <u>Ore Bridge Stairwells and Landings</u>: Steel framed stairwells and landings leading from the ground to the top of the ore bridge span are located at the pier leg and shear leg ends of the bridge.

HISTORY

The raw materials handling and storage system was originally built in 1896 as part of the construction of a new blast furnace plant at the Duquesne Works. Its successful inclusion of an ore yard with a stocking bridge system was such a radically new principal for its time that it was referred to as the "Duquesne Revolution." The new system lowered the costs and improved production flexibility in the handling and storage of raw materials (i.e. coke, limestone, and iron ore).

Before its introduction, raw materials were dumped from railroad hopper cars run onto an elevated trestle, and manually moved by wheelbarrow directly to the stockhouse where the skip car or bucket was filled. Moreover, because winter weather prohibited the shipping of the relatively rich ores from the Lake Superior region by boat, blast furnace operators were forced to either pay higher transportation costs in order to obtain these ores by rail during winter months, or use local ores of a lesser quality.

The construction of the ore yard at Duquesne solved the latter problem. Originally 226'-0" wide x 1,085'-0" long x 26'-0" deep, and laid out in front of the plant's four original blast furnaces, the ore yard was capable of storing 600,000 tons of ore. Consequently, enough ore from the Lake Superior region could be stored in the yard during the warm weather months to allow for its use year round. The former problem, that of high labor costs, was solved by the use of electrified ore stocking bridges, operated by one man, in conjunction with a system of stockhouse bins which were hung from a trestle that lay between the ore yard and the blast furnaces. When ore was being handled, railroad hopper cars were moved, via a car puller, onto the outside tracks of the trestle. The bins into which the ore was dropped were equipped with two counterbalanced chutes capable of delivering it into either the stockhouse bins themselves or into a bucket which was placed in the ore yard directly below the chute. In the latter case, the bucket was picked up by one of three Brown Hoisting & Conveying Machine Company ore bridges and delivered to one of several storage piles contained within the ore yard. When it was required to move ore from one of the various storage piles to the stockhouse ore bins, a 5-ton bucket scoop was attached to the hoisting machinery on the ore bridge trolley in order to deliver the ore from the pile to a railroad hopper car which was then positioned over the designated stockhouse ore bin where the hopper car dumped its contents. Coke and limestone was dropped directly into its assigned stockhouse bin by a railroad hopper car which was moved onto the trestle, there being no attempt to carry a stock of these materials.[1]

With the exception of increasing the length of the ore yard and the trestle in order to accommodate two additional blast furnaces built in 1901, the operation of the raw materials handling and storage system remained the same until the period between 1918 and 1928. In that period the system was reconstructed in a effort to keep pace with technological advances within the industry. The coke track system on the trestle, for example, was realigned to accommodate the movement of the coke bins from the eastern wall of the stockhouse to new locations which straddled newly constructed hoist bucket pits for each blast furnace. A car dumper was installed along with its electrically powered 110-ton ore transfer rail cars. The car dumper was designed to overturn one railroad hopper car full of iron ore at a time, thereby dumping its contents into the hoppers of an ore transfer car which was set below it. The transfer car, designed and built by the Atlas Car Manufacturing Company of Cleveland, Ohio, was then run onto the trestle to an assigned ore bin before its bottom dropped the ore into one of the counterbalanced chutes leading directly to the bin itself or to the ore yard proper. The installation of the dumper system dramatically increased the rate of speed of the handling and storage of iron ore. In 1928 a new car puller system was installed on the coke trestle serving blast furnaces number one and two. Finally, in that same year, two 10-ton ore bridges replaced their original counterparts.[2]

Alterations to the raw materials handling and storage system between 1928 and 1953 were limited to minor repairs on the coke trestle. Between 1954 and 1962, however, the system was almost completely revamped. A new 15-ton ore bridge, designed and constructed by the Heyl and Patterson Company of Pittsburgh, PA, was installed in 1954. The new ore bridge was constructed after a fire which destroyed one of the 10-ton bridges installed in 1928. A new 150-ton rotary car dumper and conveying system, also designed and constructed by the Heyl and Patterson Company, replaced the old car dumper arrangement in 1959. Under the new system, a railroad hopper car, filled with ore or limestone, was run into the car dumper contained within the car dumper building. As the hopper car reached its destination, its wheels were clamped by the dumper's platen locks after which the mechanism automatically began to rotate. Upon a rotation of 15 degrees, the dumper's clamp beams automatically moved downward, gripping the top of the car for the remainder of its 160 degree rotation. Raw materials from the hopper car were thereby dumped into three hoppers, rated at a capacity of 50 tons each, which were located directly below the car dumper. From the hoppers the raw materials were delivered to a system of 48" conveyor belts, connected in series, by means of three rotary table feeders located directly below the hoppers. The conveyor belts, running parallel to, and located between the trestle and ore yard, delivered the raw material to one of two tripper cars which diverted the material into an assigned stockhouse bin or into the ore yard where it was relocated into one of the various stock piles by an ore bridge. As such, this newly installed stocking system, capable of delivering 3500 tons of raw material per hour to the stockhouse bins or ore yard, represented a dramatic increase in productivity over the system installed in 1928.[3]

In 1960, as part of the construction of a replacement for blast furnace number six, another 15-ton ore bridge, designed and built by the American Bridge Company, was added, superseding the other 10-ton ore bridge built in 1928. During the next two years the trestle at blast furnace number six was altered in order to meet the specifications of its newly built stockhouse. Three new car pullers were installed at the trestle for blast furnace number six and the car pullers serving the coke trestle at blast furnaces numbers one, two, three, and four were replaced.[4]

Between 1962 and 1984, when the Duquesne Works shut down, the only alteration of consequence was the replacement of the rotary table feeders located below the 50-ton hoppers at the car dumper by vibrating feeders attached directly to the hoppers in 1970.[5]

ENDNOTES:

1.Harold E. McGannon, ed., The Making, Shaping, and Treating of Steel, Eighth Edition, (Pittsburgh: 1964), 9; "The Duquesne Furnaces of the Carnegie Steel Co., Ltd.," The Iron Trade Review 30 (March 25, 1897): 7; "The Duquesne Furnace Plant of the Carnegie Steel Company Limited," The Iron Age 59 (March 25, 1897): 5-7; Carnegie Steel Company, "Foundation Plan of Stock Yards for Blast Furnaces No. 1 and 2: Drawing #1332A, August 27,1895."; Carnegie Steel Company, "Foundation Plan of Stock Yards for Blast Furnaces No. 3 and 4: Drawing #1332B, December 16, 1895."

2.United States Steel Corporation, "Aerial Survey Guide, Physical Inventory Ore Stockyard, Blast Furnace Department: Drawing #29745, August 26, 1958."; Duquesne Times, April 5, 1918; "New Iron and Steel Works Construction," The Iron Age 105 (January 1, 1920): 100; Carnegie Steel Company, "Plan Showing Location of Rail Splices, Rails for Trestle Tracks (Coke Trestle), 6th Lining - Reconstruction, No. 1 Blast Furnace: Drawing #15033, May 5, 1923," "General Arrangement of Coke Trestle, Sixth Lining - Reconstruction, No. 2 Blast Furnace: Drawing #15416, January 28, 1924," "General Arrangement of Car Puller On Coke Trestle, No. 2 Blast Furnace: Drawing #17471, February 28, 1928," "Bumpers, Ore Bin Side Stockyard, 10 Ton Ore Bridges, Blast Furnaces: Drawing #17407, October 11, 1927," "General Arrangement, Extension of Ore Bridge Runway, 10 Ton Ore Bridge, East and West Side of Stockyard, Blast Furnaces: Drawing #17828, March 28, 1928," "Extension of Ore Bridge Runway, 10 Ton Ore Bridge, East and West Side of Stockyard, Blast Furnaces: Drawing #17819, May 21, 1928."

3.Carnegie-Illinois Steel Corporation, "Location Diagram and Details of Track Stringers To Be Reinforced, Coke Trestle, No. 5 Furnace: Drawing #20933, June 16, 1938," "Alterations to Track Stringers for Coke Bins, Blast Furnaces No. 1 & No. 2: Drawing #21140, October 2, 1939," "Repairs to Coke Trestle at No. 1 & 2 Blast Furnaces, Plan and Section Present Structure: Drawing # 24867, April 25, 1950," "Repairs to Coke Trestle at No. 1 & 2 Blast Furnaces, Plan - Floor and Track Support Structures: Drawing #24869, April 28, 1950."; United States Steel Company, "Clearance Diagram, 15 Ton Ore Bridge No. 3, Blast Furnaces: Drawing #25454, September 26, 1953."; United States Steel Corporation, "Key Diagram - Ore Bins & Conveyors - South End, Rotary Car Dumper, Blast Furnace Area: Drawing #30424, May 13, 1957," "Key Diagram - Ore Bins and Conveyors - North End, Rotary Car Dumper, Blast Furnace Area: Drawing #30425, May 6, 1957,"; Heyl and Patterson Inc., Instructions for Operation, Maintenance, and Lubrication of Rotary Railroad Car Dumper with Retarder (Pittsburgh: 1958), 2-7; Heyl and Patterson Inc., Railcar Dumping Systems (Pittsburgh: 1985), 3; United States Steel Corporation, "Information Sheets - Car Dumper and Conveying System for Duquesne Works," (Duquesne: 1956), 3-4.

4.United States Steel Corporation, "General Arrangement - Duquesne Works, Duquesne, PA - No. 4 Ore Bridge, 15 Ton Capacity: Drawing #48435, August 8, 1960," "General Arrangement and Field Work, Trestle Car Puller, 28'-0" Blast Furnace #6: Drawing #48385, August 30, 1962."; Stephens-Adamson Mfg. Company, "General Arrangement of Item #1, 10,000# Continuous-Reversible Wire Rope Car Puller W/Rope Speed of 40 F.P.M. for U.S. Steel Corp. Duquesne Works, Duquesne, PA: Drawing #53685, April 14, 1962," "General Arrangement of Item #2, 10,000# Continuous-Reversible Wire Rope Car Puller W/Rope Speed of 40 F.P.M. for U.S. Steel Corp. Duquesne Works, Duquesne, PA: Drawing #53686, June 14, 1962,"; United States Steel Corporation, "General Arrangement Car Puller, Coke Trestle, No. 2 Blast Furnace: Drawing #49942, January 29, 1962," "Beams B1 to B24 Inclusive, Car Puller, No. 3 & No. 4 Blast Furnaces: Drawing #29876, February 29, 1960."

5.United States Steel Corporation, "Feeder and Hopper Arrangement, Vibrating Feeder System, Rotary Car Dumper, Blast Furnace Area: Drawing #58878, July 3, 1970."

* All original drawings cited are in the possession of U.S.X. United States Steel Division, Engineering Office, Clairton, PA.

<u>Historic Name</u>: U.S. Steel Corporation, Duquesne Works, Blast Furnace Plant, Raw Materials Delivery System
<u>Present Name</u>: U.S.X. Corporation, National-Duquesne Works, Blast Furnace Plant, Raw Materials Delivery System
<u>Location</u>: Upper Works
<u>Construction</u>: 1896, 1923-24, 1953-54, 1960-62
<u>Documentation</u>: Photographs of the Duquesne Blast Furnace Plant located in HAER No. PA-115-A.

DESCRIPTION

I. <u>Blast Furnace Number One</u>:

A. <u>Stockhouse</u>:

1. <u>Stockhouse Building</u>: The stockhouse building, laid out on a north-south axis, is constructed of rough-faced ashlar and is 77'-0" wide x 1456'-0" long x 40'-0" high. The trestle's steel platform forms the roof of the building which is supported by a cross-braced steel column frame.
Construction Date: 1896.

2. <u>Ore and Flux Scale Car</u>: The scale car ran along the western side of the stockhouse while being powered by an electrical rail which is attached to the western wall. The car is equipped with two pneumatically operated weigh hoppers. One hopper has a capacity of 32,000 lbs., the other 24,000 lbs. The motor, air compressor, and air receiver arrangement which operates the weigh hopper dumping system is unidentifiable.
Installation Date: 1924.

3. <u>Ore and Flux Bins</u>: The "Baker" suspension type ore and flux bins are hung from the steel framework of the trestle over the western, or ore yard wall of the stockhouse. Their bottom openings are arranged along the western wall of the stockhouse for blast furnaces 1, 2, 3, and 4 above the scale car. Their capacities are unknown at this time.
Construction Date: 1924.

4. <u>Coke Bin</u>: A 14-ton double coke bin, constructed by the American Bridge Company, spans the hoist bucket pit and has openings on the north and south side of the pit. The bins are hung from the steel framework of the trestle underneath the coke track. Attached to each bottom opening of the bin is a weigh hopper. The dumping system, which is attached to each weigh hopper bottom opening, is composed of a inclined Vibrolator vibrating coke screen and a chute leading to the hoist bucket at the bottom of the pit. A 2 hp motor attached to the top of the

screen provides the power for vibration. Associated with the screen is a mechanical gate outfitted with a weight on each side of it. The gate was used to restrain the coke when it was not being charged into the hoist bucket.
Construction Date: 1924.

5. Hoist Bucket Pit: Located 120'-0" from the north wall of the stockhouse and 31'-6" from the east wall, the concrete hoist bucket pit is 13"-0" wide x 26'-4 1/2"" long x 18'-2 1/2" deep.
Construction Date: 1924.

6. Motor and Turntable for Hoist Bucket: Located in the center and on the floor of the hoist bucket pit is a 5'-10" diameter x 2'-9/16" thick bell shaped turntable attached by two nearly perpendicular line shafts to a 15 hp W. C. & Manufacturing Company motor operating at 600 rpm. The motor is located in a 5'-0" wide x 6'-3" long x 4'-0" deep enclave in the center of the western wall of the hoist bucket pit.
Construction Date: 1924.

7. Hoist Track and Carriage: The carriage is an 11 1/2" thick steel plate mounted on steel rail wheels. The centerline distance between the front and back wheels is 9'-0", the distance across the centerline of the wheels is 8'-8 1/8". Hanging from the centerline of the front axle is the stem of the hoist bucket. The hoist track consists of a set of rails, 8'-1 1/8" apart, mounted to a 167'-0" high inclined bridge leading to the top of the furnace along its centerline. The incline of the truss is broken into two segments. It rises at an angle of 70 degrees to a height of 133'-0" where it becomes a 58 degree angle to the furnace top.
Design date: 1924.

8. Hoist Bucket: There is one hoist bucket (capacity level full = 250 cu. ft.) mounted on the carriage which is set on the hoist track leading to the top of the furnace. The bucket is 6'-10" in diameter x 8'-6 7/8" high. The bottom 3'-2 3/8" of the bucket is beveled at an angle of 24 degrees. Inside of the bucket is a spider mounted on its inside wall. The spider helps desegregate the coarse and fine particles in the charge while the bucket revolves on the turntable. The bottom of the bucket is made up of a 4'-1" diameter movable bell attached to the stem of the carriage.
Design Date: 1924.
Construction Date: 1968.

9. Coke Breeze Feeder Conveyor: 20" conveyor belts (capacity = 110 feet per minute), manufactured by The C. O. Barlett and Snow Company of Cleveland, Ohio, run from the

respective coke bin openings to the main coke breeze conveyor belt at an angle of approximately 25 degrees from the stockhouse floor level. The electric motor powering the north side conveyor belt is an Allis-Chalmers 3 phase 60 cycle, 3 hp motor operating at 1740 rpm. The south side conveyor belt is powered by a General Electric 3 phase 60 cycle, 3 hp motor operating at 1750 rpm. Each motor is attached to a 3 hp Strait Line gear motor.
Installation Date: 1959.

10. Main Coke Breeze Conveyor: A 24" conveyor belt (capacity = 131 feet per minute), manufactured by the C. O. Barlett and Snow Company of Cleveland, Ohio runs along the entire length of the eastern wall of the stockhouse from blast furnace number one to a chute leading to the coke breeze skip car located in the stockhouse of blast furnace number six. The belt is powered at three drive stations. The drive unit north of blast furnace number 3 contains a Reliance 5 hp, 1020 rpm motor attached to a 5 hp Western Gear Reducer. The drive unit south of blast furnace number 4 contains a General Electric 3 hp, 1750 rpm motor attached to a 5 hp Western Gear Reducer. The drive unit at the blast furnace number 6 stockhouse end of the belt contains a General Electric 20 hp, 1750 motor attached to a Falk Gear Reducer with a ratio of 46.94:1.
Installation Date: 1959.

11. Control Room: The control room for blast furnace number one is located between the coke bins on the centerline of the furnace just west of the hoist bucket pit and is approximately 4'-0" wide x 10'-0" long x 8'-0" high. It is equipped with a Koppers control panel which regulates the operation of the vibrating coke screens, the hoist buckets, and the large bell at the furnace top.
Installation Date: Circa 1940.

12. Counterweight Hoist Tower: On the east wall of the stockhouse just south of the hoist bucket pit is the counterweight hoist tower. The tower rises to the level of hoist house number one. It is constructed of structural I-beams and is 5'-3 1/4" wide x 9'-1 1/2" long x 77'-1 1/4" high. The counterweight system consists of three pairs of 6'-1 1/4" sheave wheels, one of which is located below the hoist house at a 45 degree angle. The sheave wheels are connected by 1 1/4" diameter hemp ropes, leading from the winch drum assembly located in the hoist house, which are attached to two counterweights that run on rails up and down the counterweight hoist tower as the hoist bucket travels along the hoist track.
Construction Date: 1924.

B. Hoist House:

1. Hoist House Building: The hoist house building is 25'-9" wide x 42'-4" long x 18'-0" high (from the floor to the underside of the truss), and is mounted on a platform supported by steel columns which extend 40'-0" above the trestle. It is located approximately 15'-0" west of the centerline of blast furnace number 1. The building is supported by steel columns at its north and south end. The columns are welded to steel plates which are bolted to the concrete floor. At the north and south end of the building are Fink roof trusses. The gabled roof building has a corrugated metal exterior.
Construction Date: 1924.

2. Motor-Generator Set: Located in the northwest corner of the hoist house building is a 3 phase, 25 cycle Westinghouse induction motor with rated specs of 350 hp, 440 volts, 735 rpm at full load, and 394 amps per terminal. It is connected on its north end to a 240 kw Westinghouse D.C. generator with specs of 600 volts, 400 amps and 735 rpm.
Installation Date: 1924.

3. Main Circuit Board: In the northeast corner of the hoist house building is a Westinghouse circuit board labeled 440 volts, AC-25. It contains switches for the generator, the two skip incline motors, and the two stock line test motors. Located on top of the circuit board are four electrical resisters.
Installation Date: 1924.

4. Hoist Bucket Incline Motor, Drive, and Winch Drum Assembly: In the middle of the hoist house building are two parallel General Electric D.C. motors running in a north-south direction. The specs for each are 140 hp, 230 volts, 515 amps, and 400 rpm. Both motors are connected to a Lidgerwood gear drive on their southern end. Both gear drives are attached to a larger Lidgerwood gear drive located just south of them. The large gear drive is connected to a 6'-0" diameter winch drum which is wrapped with two 1 1/4" diameter hemp ropes leading to the hoist carriage and a 6'-0" diameter sheave wheel at the top of the furnace, and two 1 1/4" diameter counterbalance hemp ropes. Each rope travels about 186'-0". Attached to the large gear drive west of the motors is a Koppers governor system. On the north end of the system is a bottom limit switch for the hoist bucket, on the south end is the hoist bucket top limit switch.
Installation Date: 1924.

5. Stockline Test Rod Motor and Winch Drum Assembly: Located on an approximately 4'-0" wide x 20'-0" long x 10'-0"

high balcony running along the eastern wall of the hoist house building are two stockline test motor and winch drum assemblies. On the balcony's north side is a 2 hp, 8 amp, 230 volt Reliance D.C. motor which operates at 1200 rpm. It is connected to a 1'-0" diameter winch drum attached to a Jones-Herringbone speed governor. The speed governor, manufactured by Hewitt-Robins, has specs of 4.26 hp and 1200 rpm. The arrangement of the stockline test rod motor and winch drum assembly on the balcony's south side is the same as noted above with the exception of the motor. It is a 2 hp, 8 amp, 250 volt Reliance Model "T" heavy D.C. motor which operates at 1200 rpm. The steel cable which is wound around both winch drums is approximately 1/4" in diameter.
Installation Date: 1930.

6. Electric Hoist: A 10-ton Sheppard service crane equipped with a "C" hook is suspended from a monorail located 15'-7 1/2" from the hoist house floor, which extends along the centerline between the two skip incline motors.
Installation Date: 1924.

7. Counterweight Hoist Tower: Located on a platform just south of the hoist house is the counterweight hoist tower which extends upwards from the stockhouse. See item number I - A - 12 for description.

C. Furnace Top:

1. Large Bell Hopper: The hopper which sits above the large bell at the top of the furnace is 8'-0" high with a top inside diameter of 15'-5 1/2", tapering to a bottom inside diameter of 13'-0". The flange surrounding the top of the hopper is 6 1/4" wide.
Installation Date: 1968.

2. Gas Seal Hopper and Seal: The gas seal hopper is approximately 4'-0" high. Its bottom flange sits on top of the large bell hopper top flange. The bottom inside diameter of the hopper is 15'-5 1/2" and its top inside diameter is 4'-1". The top diameter including the flange is 6'-3". Inside of the top inside diameter of the hopper is a hard rubber bell shaped gas seal approximately 18" high.
Design Date: 1896.

3. Large Bell: The large bell has a diameter of 14'-0" and is 9'-5" high. It is attached by a 6 1/4" shaft to a steam operated lever arm which lowers and raises it.
Construction Date: 1966.

4. Steam Cylinder: Located on the top of the furnace

approximately 4'-0" east of the large bell hopper is a 20" x 38" steam cylinder for operating the large bell.
Construction Date: 1924.

5. Platforms and Stairs: Accessibility to the equipment at the top of the furnace is provided by steel framed stairways and 1/4" thick steel platforms.
Construction Date: 1971.

II. Remains of Blast Furnace Number Two:

A. Stockhouse:

1. Stockhouse Building: See I - A - 1 for description.

2. Ore, Manganese, and Flux Scale Car: The ore, manganese, and flux scale car, manufactured by the Atlas Car Manufacturing Company of Cleveland, Ohio, ran along the western side of the stockhouse where it was powered by an electric rail attached to the western wall. The car, which delivered iron ore, manganese, limestone, and dolomite from the stockhouse bin system to the hoist bucket serving blast furnace number 2, is equipped with two pneumatically operated weigh hoppers. One hopper has a capacity of 32,000 lbs., the other 24,000 lbs. At the southern end of the car is an pneumatically operated dumping system composed of a 7.5 hp Alliance D.C. motor running at 1750 rpm, connected to a small Airtez air compressor and air receiver.
Installation Date: 1924.

3. Ore, Manganese, and Flux Bins: See I - A - 3 for description.
Construction Date: 1924.

4. Coke Bin: The coke bin for blast furnace number 2 is constructed and arranged in the same manner as the coke bin for blast furnace number 1 except that the motors which power the vibrating screens have been taken out.
Construction Date: 1924.

5. Hoist Bucket Pit: The centerline of the hoist bucket pit for blast furnace number 2 is located 31'-6" from the eastern wall of the stockhouse, and 293'-0" from the centerline of the hoist bucket pit for blast furnace number 1. Constructed of concrete, it is 13'-0" wide x 26'-4 1/2" long x 18'-2 1/2" deep.
Construction Date: 1924.

6. Coke Breeze Feeder Conveyor: The coke breeze feeder conveyors for blast furnace number 2 were of the same type and construction as the feeder conveyors at blast furnace number 1.

The conveyor belts, however, have been removed, leaving only the steel framework for the conveyors and the motor-drive assemblies which powered them. The motors on the north and south sides of the hoist bucket pit are both 3 hp General Electric A.C. motors operating at 1740 rpm. Each motor is attached to a 3 hp Western Gear Strait Line gear motor.
Installation Date: 1959.

7. Main Coke Breeze Conveyor: See I - A - 10 for description.
Installation Date: 1959.

8. Control Room: The control room for the raw materials delivery system at blast furnace number 2 is located relative to the hoist bucket pit as is the control room at blast furnace number 1. It is the same size and contains equipment which performs the same functions as the control room at blast furnace number 1.
Installation Date: 1953.

9. Counterweight Hoist Tower: The counterweight hoist tower is located on the east wall of the stockhouse just south of the hoist bucket pit. Rising to the level of hoist house number 2, it is made up of structural I-beam construction and is 5'-3 1/4" wide x 9'-1 1/2" long x 76'-6 3/4" high. The counterweight system consists of three pairs of 6'-1 1/4" diameter sheave wheels, one of which is located below the hoist house at a 45 degree angle.
Construction Date: 1924.

B. Hoist House:

1. Hoist House Building: Located approximately 15'-0" west of and on the centerline of the remains of blast furnace number 2, the hoist house building is 25'-9" wide x 42'-4" long x 18'-0" high from the floor to the underside of the truss. It is mounted on a platform supported by steel columns which extend 49'-6" above the trestle. The columns of the steel framed building are welded to steel plates which are bolted to the concrete floor. At the north and south end of the building are Fink roof trusses which support a gable roof. Its exterior is made out of corrugated metal.
Construction Date: 1924.

III. Blast Furnace Number Three:

A. Stockhouse:

1. Stockhouse Building: See I - A - 1 for description.

2. <u>Ore, Manganese, and Flux Scale Car</u>: The construction, manufacture, relative location, and function of the ore, manganese, and flux scale car for blast furnace number 3 are exactly the same as its counterpart for blast furnace number 2.
Installation Date: 1920.

3. <u>Ore, Manganese, and Flux Bins</u>: See I - A - 3 for description.
Construction Date: 1920.

4. <u>Coke Bin</u>: The construction, relative location, and arrangement of the coke bin for blast furnace number 3 is the same as the coke bins for blast furnaces number 1 and 2 with the exception that the vibrating coke screens are made by a different manufacturer. The 60" wide x 120" long x 4" thick coke screen, which is inclined at angle of 20 degrees from the mouth of the weigh hopper openings, was manufactured by the Syntron Company. A 2 hp motor powers the vibrating coke screen.
Construction Date: 1920.
Alteration of bin to fit Syntron Vibrating Coke Screen: 1969.

5. <u>Skip Pit</u>: Made up of concrete construction, the skip pit is 8'-1" wide x 14'-6" long x 20'-2 1/2" deep. Its centerline is located 40'-0" off of the eastern wall of the stockhouse and 259'-0" from the centerline of the hoist bucket pit for blast furnace number 2.
Construction Date: 1953.

6. <u>Skip Incline and Track</u>: The skip track consists of a set of rails 5'-8 1/2" apart which are mounted to a 9'-10 5/8" wide x 9'-0" high inclined bridge rising for a distance of 164'-9" to the top of the furnace along its centerline. The incline of the bridge is broken up into two segments. It rises at an angle of approximately 70 degrees to a height of 128'-3" where it becomes an approximate 58 degree angle to the top of the furnace.
Design Date: 1952.

7. <u>Skip Car and Carriage</u>: A skip car (capacity level full = 267 cu. ft.) is mounted on a carriage which is set on the skip track leading to the top of the furnace. The steel plate constructed car is 5'-2" wide x 11'-7 1/2" long x 5'-4 1/2" high. Its carriage is made up of a front and rear rail wheel and axle assembly. The centerline distance between the front and rear wheels is 7'-0". The distance between rails is 5'-8 1/2". The stem of the skip car is mounted on a trunnion, located 3'-3" from the rear of the car, and is connected to a 1 1/4" wire rope which is attached to the motor, drive, and winch drum assembly situated in the hoist house. The inside of the skip car, which is open at

the front end, is lined with 2" thick tiles manufactured by the Indusco Interstate Industrial Company of Chicago, Illinois.
Design Date: 1952.
Construction Date: 1969.

8. Coke Breeze Feeder Conveyors: See I - A - 9 for description.
Installation Date: 1959.

9. Main Coke Breeze Conveyor: See I - A - 10 for description.
Installation Date: 1959.

10. Control Room: The control room for the raw materials delivery system at blast furnace number 3 is located in approximately the same relation to the skip pit as the control room at blast furnace number 1 is located relative to the hoist bucket pit. It is the same size and contains equipment which perform roughly the same functions as the control room at blast furnace number 1.
Construction Date: 1953.

11. Counterweight Hoist Tower: Located on the east wall of the stockhouse, just south of the skip pit is the counterweight hoist tower. Made up of structural I-beam construction, it rises up to the level of hoist house number 3 and is 10'-4" wide x 12'-6" long x 76'-6 7/8" high. The counterweight system consists of three pairs of 6'-1 1/4" diameter sheave wheels, one of which is located below the hoist house at a 45 degree angle. The sheave wheels are connected by 1 1/4" diameter wire ropes, leading from the winch drum assembly in the hoist house, which are attached to two counterweights that run on rails up and down the counterweight hoist tower as the skip car travels along the skip track.
Construction Date: 1927.

B. Hoist House:

1. Hoist House Building: The hoist house building is located approximately 15'-0" west of blast furnace number 3. It is 25'-9" wide x 59'-7" long. The height of the building is 18'-0" from the floor to the underside of the truss for a distance of 42'-4" measured from its northern end. The remaining 17'-3", measuring to its southern end, is 32'-9" high from the floor to the underside of the truss. The building is mounted on a steel column supported platform which extends 49'-6" above the trestle. The columns of the steel framed building are welded to steel plates which are bolted to the concrete floor of the building. The north and south ends of the building's gable roof are

supported by fink trusses. The building has a corrugated metal exterior.
Original Construction Date: 1921.
17'-3" Extension Construction Date: 1953.

2. Main Control Panel: Located in the northeast corner of the building is a Westinghouse control panel. It contains switches for the two skip incline motors and the two stock line test motors.
Installation Date: 1921.

3. Skip Incline Motor, Drive and Winch Drum Assembly: Mounted on the floor in the middle of the hoist house building and laid out in parallel on a north-south axis are two 200 hp Westinghouse Type S.K. D.C. motors operating at 450 rpm. Connected to each motor on its southern end by a crankshaft is a Lidgerwood gear drive. Both gear drives are connected to a larger Lidgerwood gear drive by a crank shaft just south of them. The large gear drive is connected to a 6'-0" diameter winch drum which is wrapped with two 1 1/4" diameter wire hoist ropes leading to the skip car and a 6'-0" diameter sheave wheel at the top of the furnace, and one 1 1/4" diameter wire counterbalance rope. Located on the western side of the motor, drive, and winch drum assembly and attached to the crankshaft between the Lidgerwood gear drives is a Koppers limit system composed of a top and bottom travel limit switch for the skip car. Attached to the center of the southern face of the winch drum is a Logan Hoist Controller used for controlling the speed of the skip car as it ascends and descends the hoist track.
Installation Date: 1921.

4. Stockline Test Motor and Winch Drum Assembly: Located on an approximately 4'-0" wide x 20'-0" long x 10'-0" high balcony that extends along the eastern wall of the hoist house building are two stockline motor and winch drum assemblies. Laid out linearly on a north-south axis, each interconnected assembly consists of a 2 hp, 1200 rpm Reliance D.C. motor, a Jones-Herringbone Speed Reducer, and a 1'-0" diameter winch drum wrapped with a 1/4" diameter steel cable. The cable from each of the assemblies leads to the stockline test rods located at the furnace top.
Installation Date: 1936.

5. Service Crane: The service crane is suspended from a monorail located 15'-7 1/2" from the hoist house floor, and runs along the centerline between the two skip incline motors. The 10-ton crane consists of a winch drum wrapped with a small steel cable equipped with a "C" hook.
Installation Date: 1921.

6. Large and Small Bell Hydraulic Cylinders: The Koppers hydraulic cylinders for the large and small bell are laid out linearly on a east-west axis in the center of the 1953 extension at the southern end of the hoist house building. The approximately 19'-0" high large bell hydraulic cylinder has a 50" diameter. The 16'-6" high small bell hydraulic cylinder has a 38" diameter. The top of each cylinder is attached to a steel cable which runs from the hoist house to the large or small bell at the furnace top. The introduction or retraction of compressed air into or from the cylinders forces them to move up or down, thereby opening or closing the bells at the top of the furnace.
Installation Date: 1953.

7. Air Receiver and Associated Piping: Located approximately 5'-0" south of the large and small bell hydraulic cylinders is an approximately 4'-0" diameter x 9'-8" high air receiver manufactured by the Quaker City Iron Works of Philadelphia, PA in 1953. The receiver, which stores compressed air, has a system of small compressed air pipes connecting it to the hydraulic cylinders.
Installation Date: 1953.

8. Counterweight Hoist Tower: The counterweight hoist tower is located approximately 3'-0" east of the air receiver in the center of the 1953 hoist house extension. See item number III - A - 11 for description.

C. Furnace Top:

1. Large Bell Hopper: See I - C - 1 for description.
Installation Date: 1968.

2. Large Bell: The large bell is 14'-0" in diameter x 9'-5" high and is located about the centerline of the blast furnace. It is attached by a 8" diameter rod to a lever arm which is connected to and operated by the steel cable leading from the 50" diameter hydraulic cylinder located in the hoist house.
Construction Date: 1953.

3. Small Bell Hopper: The small bell hopper sits above the small bell at the top of the furnace. It is 5'-1" high with a top inside diameter of 6'-0", tapering downwards to a bottom inside diameter of 5'-3". The flange surrounding the top of the hopper is 11" wide.
Installation Date: 1953.

4. Small Bell: The 6'-0" diameter x 3'-1 1/2" high small bell is located directly above the large bell. It is attached by a 4" diameter rod to a lever arm which is connected to and

operated by the steel cable leading from the 38" diameter hydraulic cylinder located in the hoist house.
Construction Date: 1953:

5. Revolving Distributor: The revolving distributor, designed and manufactured by Arthur G. McKee & Co. of Cleveland, Ohio, sits above the small bell. It consists of 12'-6 9/16" high hopper with a top inside diameter of 7'-5 3/8" and a bottom inside diameter of 5'-5" which houses the distributor. The distributor is a small motor powered bell shaped seat which fits directly on top of the small bell. Raw materials enter the revolving distributor's hopper from the receiving hopper located directly above it.
Installation Date: 1953.

6. Receiving Hopper: The irregularly shaped receiving hopper, designed and manufactured by the Arthur G. McKee & Co. of Cleveland, Ohio, sits above the revolving distributor's hopper. It receives raw material from the skip car. The opening at its top is 5'-5" wide x 5'-11" long. Its 5'-11" diameter bottom opening fits inside of the top opening of the hopper for the revolving distributor.
Installation Date: 1953.

IV. Blast Furnace Number Four:

A. Stockhouse:

1. Stockhouse Building: See description I - A - 1.

2. Ore, Manganese, and Flux Scale Car: The scale car for blast furnace number 4 adheres to the same construction and arrangement described for the scale car at blast furnaces number 1 and 2.
Installation Date: 1921

3. Ore, Manganese, and Flux Bins: See description I-A-3.
Installation Date: 1921.

4. Coke Bin: The coke bin meets the specifications described in III - A - 4 with the exception that one 48" x 72" electromagnetic vibrating feeder, manufactured by the Eriez Magnetics Company of Erie, PA, is attached to each of the bin's bottom openings. The feeder drops its coke charge onto a Syntron vibrating coke screen located directly below it.
Construction Date: 1921.
Installation of Eriez vibrating feeder: 1968.

5. Skip Pit: The 17'-3" wide x 26'-4 1/2" long x 17'-1 1/2"

deep skip pit is built of concrete construction. Its centerline is located 35'-0" off of the eastern wall of the stockhouse and 243'-3" off of the centerline of blast furnace number 3.
Construction Date: 1953.

6. Skip Incline and Track: The skip track consists of two parallel sets of rails spaced 5'-8 1/2" apart, mounted to a 15'-6" wide x approximately 9'-0" high inclined bridge, which rises for a distance of 181'-10 1/2" from the stockhouse floor to the top of the furnace along its centerline. The incline of the bridge is approximately 60 degrees.
Design Date: 1952.

7. Skip Cars and Carriage: The skip cars and carriages on both sets of tracks meet the requirements described in III - A - 7.
Design Date: 1952.
Construction Date: 1969.

8. Coke Breeze Feeder Conveyor: See description I - A - 9.
Installation Date: 1959.

9. Main Coke Breeze Conveyor: See description I - A - 10.
Installation Date: 1959.

10. Control Room: The control room for the raw materials delivery system at blast furnace number 4 adheres to the requirements described in I - A - 11, II - A - 8, and III - A - 10.
Construction Date: 1953.

11. Counterweight Hoist Tower: The counterweight hoist tower is located on the east wall of the stockhouse just south of the skip pit. Rising to the level of hoist house number 4, the tower, which is constructed of structural I-beams, is approximately 5'-6" wide x 9'-0" long x 77'-0" high. The counterweight hoist system consists of three pairs of 6'-1 1/4" sheave wheels, one of which is located below the hoist house at a 45 degree angle. The sheave wheels are connected by 1 1/4" diameter ropes to the skip incline motor, drive, and winch drum assembly and to two counterweights which run on rails up and down the counterweight hoist tower as the skip car travels along the skip track.
Construction Date: 1921.

B. Hoist House:

1. Hoist House Building: Located approximately 15'-0" west of and on the centerline of blast furnace number 4, the hoist

house building is 25'-9" wide x 59'-7" long. The height of the building is 18'-0" from the floor to the underside of the truss for a distance of 42'-4" measured from its northern end. The remaining 17'-3", measuring from its southern end, is 32'-9" from the floor to the underside of the roof truss. The building is on a steel column supported platform which extends 29'-9 1/4" above the trestle. The columns of the steel framed corrugated metal exterior building are welded to steel plates which are bolted to the concrete floor of the building. The north and south ends of the building's gable roof are supported by Fink trusses.

Original Construction Date: 1924.

Construction Date of 17'-3" Extension: 1953.

2. Motor-Generator Set: Located in the northwest corner of the hoist house building is the motor-generator set. Laid out on a north-south axis, it is composed of a 500 hp General Electric Custom 8000 A.C. motor operating at 1180 rpm connected by a line shaft on each side to a 200 kw General Electric D.C. generator.

Installation Date: 1967.

3. Main Circuit Board: The 12'-6" long x 5 1/2" wide x 7'-6" high Clark model, main circuit board for hoist house equipment is located along the eastern wall at the southern end of the original hoist house. It was manufactured by the Koppers Company of Pittsburgh, Pennsylvania.

Installation Date: 1961.

4. Skip Drive and Winch Drum Assembly: Located in the center of the original hoist house building are the remains of the motor, drive, and winch drum assembly. They consist of two Falk Enclosed Gear Drives with a gear ratio of 6.875, each connected to a Cutler-Hammer brake assembly, which are mechanically attached to a 6'-0" diameter x 11'-2" long winch drum wrapped with 1 3/8" cable. Connected to the winch drum at the center of its southern face is a Logan Lily Hoist Controller which is flanked by two Clark model, top and bottom limit systems manufactured by the Koppers Company.

Installation Date: 1961.

5. Electric Hoist: A 10-ton electrically powered service hoist is suspended from a monorail 18'-0" above the hoist house floor and running along the centerline of skip drive and winch drum assembly. The arrangement of the hoist matches the arrangement described in section III - B - 5.

Installation Date: 1961.

6. Stockline Test Rod Motor, Drive, and Winch Drum Assembly: Two small test rod assemblies are laid out on a north-south axis on an approximately 4'-0" wide x 30'-0" long x 10'-0" high

balcony located along the eastern wall of the hoist house. Each assembly consists of a 2 hp Reliance Type T.D.C. motor which is connected, in series, to a gear drive and 12" diameter winch drum wrapped with 210 linear feet of 3/8" diameter wire rope.
Installation Date: 1960.

7. Balcony Motor-Generator Sets: Located at the north end of the balcony are two small motor-generator sets laid out on a north-south axis. The southern most set contains a 40 hp, 1765 rpm, Reliance Duty Master A.C. motor, flanked by a 6.5 kw Reliance D.C. generator on its southern side and a 21 kw Reliance D.C. generator on its northern side. The northern most set contains a 40 hp, 1765 rpm Reliance Precision Built A.C. motor flanked on its northern side by a 6.5 kw Reliance D.C. generator.
Installation Date: 1971.

8. Large and Small Bell Hydraulic Cylinders: Laid out on a north-south axis and located in the center of the 1953 hoist house extension at the southern end of the building are the Koppers Company manufactured large and small bell hydraulic cylinders. The size, arrangement and function of the cylinders match the description in section III - B - 6.
Installation Date: 1953.

9. Air Receiver and Associated Piping: Located in the southeast corner of the 1953 extension of the hoist house building is an approximately 4'-0" diameter x 9'- 8" high air receiver manufactured by the Quaker City Iron Works of Philadelphia, Pennsylvania in 1953. The air receiver, which stores compressed air, has a system of small compressed air pipes connecting it to the large and small bell hydraulic cylinders.
Installation Date: 1953.

10. Counterweight Hoist Tower: The counterweight hoist tower is located at the center of the 1953 hoist house extension near its eastern wall. See item number IV - A - 11 for description.

C. Furnace Top:

1. Large Bell Hopper: See I - C - 1 for description.
Installation Date: 1968.

2. Large Bell: See III - C - 2 for description.
Construction Date: 1953.

3. Small Bell Hopper: See III - C - 3 for description.
Installation Date: 1953.

4. Small Bell: See III - C - 4 for description.
Construction Date: 1953.

5. Revolving Distributor: See III - C - 5 for description.
Installation Date: 1953.

6. Receiving Hopper: See III - C - 6 for description.
Installation Date: 1953.

V. Blast Furnace Number Six:

A. Stockhouse:

1. Stockhouse Building: The steel framed brick exterior stockhouse, located underneath the trestle, is broken up into two segments (i. e. north and south stockhouse) about the centerline of the blast furnace. The north stockhouse is 76'-0" wide x 152'-4 1/2" long x 15'-10" high. The south stockhouse is 76'-0" wide x 168'-7 1/2" long x 15'-10" high. The eastern and western walls of stockhouse number 6 coincide with the eastern and western walls of the stockhouse for blast furnaces 1 through 4.
Construction Date: 1961.

2. Skip Pit: The 36'-0" wide x 58'-4" long x 40'-2" deep concrete skip pit is located at the eastern wall of the stockhouse about the centerline of blast furnace number 6. Laid out on a east-west axis, the pit is divided up into three segments. A 30'-0" space laid out about the centerline of the furnace contains the remains of the main bridge and double skip track which led to the top of the furnace. Flanking the remains of the main bridge and double skip track are two 9'-7 1/2" wide spaces. The space north of the main skip bridge and double track fragment contain the remains of the coke breeze bridge and skip track. The space south of the main skip bridge and double track remains contain the remains of the clean up skip bridge and track.
Construction Date: 1961.

3. Main Coke Breeze Conveyor: See description I - A - 10.
Installation Date: 1959.

4. North Stockhouse Coke Delivery System: The north stockhouse coke delivery system transferred coke from coke bins suspended from a trestle to a waiting 400 cu. ft. capacity skip car in the skip pit.
Installation Date: 1962.

a. Coke Bins: Laid out on a north-south axis, five 46,000 cubic foot capacity coke bins, spaced approximately 14'-0" apart, are located 18'-2" off of the north stockhouse's eastern wall. The centerline of the northern most coke bin is 66'-3" off the northern wall of the stockhouse. The southern most coke bin is located directly over the inclined vibrating coke screen.

b. Coke Feeder Conveyors: Attached to each of the coke bins at their bottom opening is a 42" x 72" electromagnetic feeder conveyor, manufactured by the Jeffrey Company, with a capacity of 115 tons per hour.

c. Coke Conveyor Belt: The 60" x 55'-0" long motor powered coke conveyor belt (capacity = 200 feet per minute) is laid out on a north-south axis directly below the feeder conveyors. It runs in a southerly direction.

d. Vibrating Coke Screen: A motor-driven Hewitt-Robins inclined vibrating coke screen with a capacity of 230 tons per hour is located at the southern end of the coke conveyor belt.

e. Coke Weigh Hopper: A 6-ton coke weigh hopper is located south of and below the incline vibrating coke screen.

5. North Stockhouse Flux Delivery System: The north stockhouse flux delivery system transferred limestone or dolomite from flux bins suspended from a trestle to the 400 cu. ft. capacity skip car located in the skip pit.
Installation Date: 1962.

a. Flux Bins: Laid out on a north-south axis, two 8,000 cubic feet capacity flux bins, spaced 17'-9" apart, are located 18'-2" of the eastern wall of the north stockhouse. The centerline of the northern most flux bin is located 26'-7 1/2" off of the northern wall.

b. Flux Feeder Conveyors: A 540 ton per hour capacity, 48" x 111" Jeffrey electromagnetic feeder conveyor is attached to each flux bin at its bottom opening. Each conveyor is laid out on a east-west axis.

c. Flux Conveyor Belt: A 48" x 120'-0" long flux conveyor belt (capacity = 296 feet per minute) is located to the east and below the flux bins, 36'-5" off of the eastern wall of the north stockhouse. The belt travels in a southerly direction.

d. Miscellaneous Weigh Hopper: A miscellaneous weigh hopper with a capacity of 30 tons is located below the flux conveyor belt at its southern end.

6. North Stockhouse Iron Ore Pellet Delivery System: The

north stockhouse iron ore pellet delivery system transferred iron ore pellets from trestle hung pellet bins to the 400 cu. ft. skip car located in the skip pit.

Installation Date: 1962.

a. <u>Iron Ore Pellet Bins</u>: Four 6000 cu. ft. capacity iron ore pellet bins, spaced 17'-9" apart are laid out on a north-south axis 45'-2" off of the eastern wall of the north stockhouse. The centerline of the northern most pellet bin is located approximately 83'-0" off of the northern wall. The southern most pellet bin is located directly over the miscellaneous weigh hopper.

b. <u>Pellet Feeder Conveyors</u>: A 540 ton per hour, 48" x 111" Jeffrey electromagnetic feeder conveyor, laid out on a east-west axis, is attached to each iron ore pellet bin at its bottom opening.

c. <u>Iron Ore Pellet Conveyor Belt</u>: A 48" x 60'-0" long conveyor belt (capacity = 296 feet per minute) is located to the east of, and below the iron ore pellet bins, 36'-5" off of the eastern wall of the stockhouse. The belt runs above the flux conveyor belt in a southerly direction.

d. <u>Miscellaneous Weigh Hopper</u>: See description V - A - 5 - d.

7. <u>North Stockhouse Sinter, Sinter Fines, and Scrap and Scale Delivery System</u>: This system transferred the designated raw material from trestle hung bins to the 400 cu. ft. capacity skip car located in the skip pit.

Installation Date: 1962.

a. <u>Bins</u>: Two 6000 cu. ft. capacity sinter bins, one 6000 cu. ft. capacity sinter fines bin, and one 3000 cu. ft. capacity scale and scrap bin, laid out on a north-south axis, are spaced 17'-9" apart. Located 45'-2" off the eastern wall of the north stockhouse, the sinter bins are the northern most bins with the scrap and scale bin located at the southern end. The centerline of the northern most sinter bin is located 8'-10 1/2" off of the northern wall.

b. <u>Feeder Conveyors</u>: Attached to each of the bins at their bottom opening is a Jeffrey electromagnetic feeder conveyor which is laid out on a north-south axis. The sinter bins are each equipped with a 594 ton per hour, 48" x 111" feeder conveyor. A 450 ton per hour, 36" x 72" feeder conveyor is attached to the sinter fines and scrap and scale bins.

c. Sinter Fines Screen: Located below each sinter bin feeder conveyor is a 226 ton per hour, 72" x 96" vibrating screen for separating out the sinter fines from the sinter bins.

d. Main Conveyor Belt: The 48" x 133'-6" long main conveyor belt (capacity = 260 feet per minute) is laid out on a north-south axis directly below the bins and screens. It runs in a southerly direction.

e. Weigh Hopper: A 30-ton weigh hopper is located below the main conveyor belt at its southern end.

8. South Stockhouse Delivery Systems: The arrangement of the equipment making up the delivery systems in the south stockhouse are a mirror image of the equipment arrangement in the north stockhouse.
Installation Date: 1962.

9. Main Control Room: Located above the conveyor belt systems on a 16'-0" high steel framed platform approximately 10'-0" west of the skip pit is an approximately 6'-0" wide x 10'-0" long x 8'-0" high main control room for the north and south stockhouse. Contained within it are lights and switches which monitor and regulate all activity taking place in the stockhouse for blast furnace number 6.
Construction Date: 1962.

HISTORY

Originally built in 1896, the raw materials delivery system was part of the construction of a new blast furnace plant at the Duquesne Works which consisted of four furnaces. In 1907 two additional blast furnaces were constructed. The system delivered raw materials (i.e. coke, limestone, and iron ore) to the top of each furnace, automatically, and was considered an outstanding feature of the plant. Designed by M. A. Neeland, superintendent of the drafting department at the Duquesne Works, the system enabled the blast furnace plant to set world production records and cut labor costs by 50 percent.[1]

Before the application of Neeland's design, loading or charging the blast furnace was performed by manual labor. Men loaded wheel barrows on the ground and drove them to a hoist at the base of the furnace where they were lifted up by a steam engine attached to a block and pulley system to the furnace top. After reaching the top, the barrows were taken over by men called top fillers, who manually dumped their contents into the furnace.[2]

The Neeland charging system utilized a system of bins which were installed in a stockhouse constructed below the ground. The bins, located along the east and west wall of the stockhouse and composed of two counterbalanced chutes extending on each side of the ore yard wall, released their raw materials into one of three 75 cu. ft. capacity hoist buckets which were equipped with a movable bell shaped bottom, and were located on a rail car outfitted with a weighing scale. After the proper amount had been charged into the hoist bucket, the car was pushed by a small locomotive to the base of the inclined hoist track located approximately 50'-0" west of the centerline of the furnace. A bifurcated hook hanging from the front axle of the hoist carriage picked off the bucket handle extending from its stem and the bucket was hoisted to the top of the furnace by means of a 14" x 16", 300 hp Crane vertical reversing steam engine located in one of the original hoist houses. When the bucket neared the top of the furnace, gauges located on a panel board in the hoist house alerted the hoisting engineer to slow down the speed of delivery by adjusting governing valves attached to the steam engine while the carriage was lowered into a sliding frame, allowing the lower flange of the bucket to rest upon the gas seal hopper of the furnace. As the sliding frame continued to lower, the bell shaped bottom of the bucket moved away from its casing and pushed a gas sealing bell down with it, allowing the raw materials to drop down evenly over the main bell of the furnace. The main bell was then lowered by means of a compressed air cylinder, controlled and operated inside of the hoist house by the hoisting engineer, releasing the raw materials into the furnace.

The Neeland raw materials delivery system made it possible to use the potentially more productive fine iron ores of the Mesabi Range. Fine ores, if not distributed evenly inside of the furnace alongside coarser ores, often stuck to the inside wall often clogging the furnace, resulting in the creation of a void between stock levels. As a result, explosions or "slips" occurred inside the furnace as the bridged stock eventually fell downwards filling the void. Production and human safety suffered because the "slip" caused raw materials to spew out of the furnace top. Until the application of the Neeland design, the only way to insure even distribution of these ores was by the use of the slower hand filling methods. Neeland counteracted the problem of "slips" by designing the system so that the centerline of the movable bucket bell coincided with the centerline of the large bell and furnace itself when the materials were discharged from the bucket, thus insuring a more even distribution.[3]

Many of the physical features of the raw materials handling system for blast furnaces numbers 1 through 6 were reconstructed between 1918 and 1924 as part of an effort to keep pace with industry wide design and technological advances.[4] While maintaining the basic principle of the Neeland process, the reconstruction improved furnace production by providing for the removal of fine coke breeze from the system, increasing the speed of materials handling, adding capacity to the hoist bucket, enhancing the distribution of iron ore within the hoist bucket, and by utilizing more efficient hoisting facilities. As a result, furnace capacity was increased from approximately 600 tons of pig iron per day to 900 tons per day.

Coke bins were removed from the eastern wall of the stockhouse and a double hopper bin, hung from the steel framework of the reconstructed coke track on the trestle, was installed directly over each of the newly constructed hoist bucket pits. The opening at each hopper, located above and to the north or south of the hoist bucket pit walls, led the coke directly over a 8'-11 5/8" x 8'-3 13/16" inclined screen which was used to separate out coke dust or breeze. The breeze dropped through the screens into a hopper which led to a chute delivering it to the coke breeze conveyor. Each conveyor, traveling in a northeast or southwest direction, deposited its contents into one of the two coke dust bins per furnace located along the eastern wall of the stockhouse. An electric powered coke dust larry car removed the breeze when the coke dust bins became full.[5]

Materials handling was improved by replacing the hoist bucket/flat rail car arrangement for delivery to the hoist carriage with a system made up of hoist bucket pits, direct coke charging facilities, electrical rail powered scale cars, and a rearrangement of the bin system. After the coke passed over the screens, it dropped into a chute which led directly into the hoist bucket located in the center of each of the newly constructed pits. The remaining raw material bins (limestone and iron ore) were reconstructed over the ore yard wall. The bins, following the "Baker" suspension system, were hung from the steel framework of the trestle. Their manually operated openings were located just inside the wall and above a rail track system set upon the stockhouse floor. The raw materials from the bins were discharged into a scale car running along the track system by an operator who pulled down on the handle of the bin opening thereby allowing the materials to fall into one of two weigh hoppers attached to the car. After discharge, the car transported the materials to the western side of the hoist bucket pit where the weigh hoppers were pneumatically opened and the contents were emptied into one of two chutes leading to the hoist bucket.[6]

The hoist bucket itself was enlarged to 250 cu. ft. full capacity and was attached by its stem directly to the hoist carriage. In order to improve the distribution of the charge into the furnace, a turntable was installed on the floor in the middle of the hoist bucket pit. The bucket, resting on the turntable, was rotated after filling so as to insure the even distribution of large and small pieces of material.[7]

After rotation, the bucket was hoisted up an inclined track resting on a reinforced bridge to the furnace top by means of electrified equipment placed in a relocated hoist house at each blast furnace. The hoist house was moved upwards, closer to the center of gravity of the hoisting system, from the ground to the top of a steel framed platform at an elevation of 40'-0". In addition, a counterweight hoist tower extending upwards from the stockhouse floor was constructed just south of each hoist house. By using this design, plant engineers were able to significantly lessen the workload of the hoisting machinery. The electrified hoisting machinery converted alternating electrical current drawn from plant power stations by means of a direct current motor-generator set before transferring the converted current to a motor/drive/winch drum assembly which hoisted the bucket up the incline. Regulating the speed of hoist travel was made easier by the use of direct current and by the attachment of automatic governing equipment to each motor/drive/winch drum assembly. Finally, steam operated equipment for regulating the large bell was installed in the stockhouse and on top of each furnace.[8]

Between 1924 and 1953 adjustments to the individual blast furnace raw materials delivery systems were relatively minor. In the 1930s, for example, vibrating coke screens operated by 2 hp motors (manufactured by The W. S. Tyler Company), replaced the stationary screens in the coke breeze separation process and a small motor/drive/winch drum assembly was installed in each hoist house for the stockline recorder. The period between 1953 and 1962, however, witnessed a second major reconstruction and upgrading of the system. It consisted of replacing the Neeland system at blast furnaces numbers 3 and 4 with a system designed by the Arthur G. McKee Company of Cleveland, Ohio, dismantling blast furnaces numbers 5 and 6, the construction of a new blast furnace number 6 (Dorothy 6), and the alteration of the coke breeze removal process.

The Neeland arrangement was replaced at the time of the scheduled relining of blast furnaces 3 and 4 in 1953 and 1959 respectively, because the McKee system allowed furnace men to significantly increase iron production by increasing the capacity of raw materials charged into the furnace over each twenty-four hour period. This was especially evident at blast furnace number 4 where the inclined bridge of the Neeland design was replaced by a bridge designed to support two 267 cu. ft. capacity skip cars. The new bridge was made possible because skip cars could be supported by notably less reinforcement than the hoist bucket. Additionally, a new skip pit was constructed in the stockhouse to accommodate the skip cars, new equipment was installed at the furnace top in order to facilitate charging, and an extension to the hoist house was built for the addition of two hydraulic cylinders which operated the newly installed bells at the top of the furnace.

The McKee process was adapted to the existing stockhouse system of bins and scale cars which filled alternating skip cars with raw materials while they were in the number 4 skip pit. After filling, the skip cars were hoisted by a new dual drive 200 hp motor/drive/winch drum assembly, manufactured by the Superior - Lidgerwood - Mundy Company and located in the hoist house, to the top of the furnace where the raw materials were deposited into a receiving hopper which delivered them, by gravity, to the hopper containing the revolving distributor. The bell shaped distributor sat directly on top of the small bell. Upon its rotation, compressed air was introduced into the small bell's hydraulic cylinder thereby beginning the reaction which simultaneously raised the cylinder and lowered the lever arm connected to the small bell at the top of the furnace. As the small bell was lowered the desegregated material dropped onto the large bell. The small bell was raised back up to its gas seal position by withdrawing the compressed air from its cylinder, after which the process was repeated with respect to the large bell's raising and lowering apparatus in order to drop the materials into the furnace proper. As one skip car was dropping its contents into the charging equipment at the furnace top the other was being filled with materials in the skip pit.

The adaptation of the raw materials delivery system to the McKee arrangement at blast furnace number 3 involved only the replacement of the 250 cu. ft. hoist bucket with one 267 cu. ft. skip car. Additional increases of the capacity of blast furnace number 3 were impractical because of the character of its production. During this time the furnace only produced ferro-manganese, a product which melted at such high temperatures that a constant vigilance was required in order to prevent it from burning through the furnace lining and shell.[9]

The construction of Dorothy 6 between 1960 - 1962 was undertaken to replace dismantled blast furnaces numbers 5 and 6. Designed and built by John Mohr and Sons of Chicago, Illinois, the furnace produced more than twice the iron generated by the dismantled furnaces together. It did so because of its large hearth diameter (28'-0"), its large working volume (58,340 cu. ft.) and because of the installation of the most modern raw materials delivery system for its time. Novel features of the delivery process consisted of its trestle supported suspension bin system and automatic stockhouse equipment as well as upgraded charging equipment at the top of the furnace which included a three bell arrangement. Moreover, the computer controlled system gave the appearance of independent operation.

The delivery of raw materials to the blast furnace top began with their transfer in the stockhouse from bins hung from the steel work of the trestle to two automatic conveying systems leading to one of two 400 cu. ft. skip cars located in the center of the furnace's skip pit. The skip pit divided the stockhouse into two halves, north and south. The equipment located in the north stockhouse filled the skip car positioned on the northern most track of the inclined skip bridge. The skip car's southern counterpart was filled by the equipment of the south stockhouse. The arrangement of the equipment in each stockhouse represented a mirror image of each other.

Coke was fed onto one of two 60" motor powered conveyor belts located in the north or south stockhouse from four 46,000 cu. ft. capacity bins via feeder conveyors which were directly attached to the coke bins at each of their bottom openings. Each main coke conveyor belt, traveling toward the skip pit, carried its material over a 230 ton per hour Hewitt-Robins vibrating inclined screen where the coke breeze was separated out. The screen delivered the main charge directly into a 6-ton weigh hopper which weighed the coke before releasing the proper amount into a chute leading to its respective skip car. An additional 46,000 cu. ft. coke bin, located directly above each vibrating screen, was designed to provide the system with coke in case of a failure with the conveying system.

Fluxing material from two north or south stockhouse 8,000 cu. ft. capacity bins were fed onto each of their own 48" motor powered conveyors by feeder conveyors attached to their bottom openings. The material traveled directly to a 30-ton weigh hopper which weighed it before releasing the proper amount into a chute leading to a skip car. Pellets from three 6,000 cu. ft. capacity north or south stockhouse bins were delivered via each of their own 48" conveyor belts to the waiting skip car in the same manner as the fluxing material with the exception that an additional ore bin was located directly above each miscellaneous weigh hopper in case of conveyor failure. Sinter from each of two north or south stockhouse 6,000 cu. ft. capacity sinter bins was transmitted by feeder conveyor over a 226 ton per hour vibrating screen where the sinter fines were separated out. Each screen delivered the main charge onto a 48" wide motor powered conveyor belt which delivered it to a sinter weigh hopper where it was weighed and fed through a chute to a waiting skip car.

The north and south stockhouse sinter conveyor belts also serviced one 6,000 cu. ft. capacity sinter fines bin and one 3,000 cu. ft. capacity scrap and scale bin each, the material from these bins passed through a sinter weigh hopper before being delivered by a chute to its respective skip car.

Upon being filled with raw material, the skip car was hoisted up to the top of the furnace by means of a 275 hp direct current motor/drive/winch drum assembly located in the elevated hoist house. After reaching the furnace top, the car dumped its contents into a receiving hopper where it was delivered by gravity to the hopper of the revolving distributor. The distributor sat directly on top of the small bell and was designed to have a flexible rotating system. It could be set to rotate a preselected number of degrees in increments of 60 degrees after the dumping of each skip car or it could be set to spin continuously immediately before and during the dumping of each car. Subsequently, the small bell was lowered by means of a compressed air powered hydraulic cylinder located in the hoist house until it had dropped its load onto the intermediate bell. The lowering of the intermediate bell was accomplished in the same manner in order to drop the raw materials onto the large bell. Operation of the large bell was set to dump its contents into the furnace proper after a preselected number of skip loads had passed through the upper two bells onto it. The primary advantages of the three bell system was its ability to handle the larger raw material requirements of Dorothy 6 and to facilitate the charging of raw materials into a furnace operating with high top pressures without the loss of valuable gases.[10]

The coke breeze removal system was altered in 1960 in conjunction with the construction of Dorothy 6. The existing conveyor and coke dust larry cars were succeeded by a 3 hp motor powered 20" conveyor belt carrying coke breeze from the dust hoppers under the vibrating coke screens to a 24" motor powered main coke breeze conveyor running along the entire eastern wall of the stockhouse to the newly built stockhouse for Dorothy 6. From there the coke breeze was dropped into a chute leading down through a skip pit into a waiting skip car with a capacity of 50 cu. ft. The skip car was periodically hoisted to an above ground bin where it deposited its contents.[11]

During the late 1960s the Neeland designed system at blast furnace number 2 was dismantled along with the furnace itself. This was the result of a "breakout" of molten ferro-manganese through the lining and shell at the furnace's hearth.[12]

When the blast furnace plant at the Duquesne Works was shut down in 1984 it contained three generations of raw materials delivery systems. The Neeland system remained operational until blast furnace number 1 was retired in 1982. Although the Neeland design represented a breakthrough in raw materials delivery technology at the blast furnace, it was adapted more widely in Europe than in America. American blast furnace plants more frequently utilized the skip car delivery system developed shortly after the Neeland process. One of the most widely used American skip car delivery systems, the McKee system, was represented at Duquesne blast furnaces numbers 3 and 4. The Mohr designed system at blast furnace number 6 represented a major upgrading of the raw materials delivery systems developed by Neeland and McKee. Its computer controlled system was able to deliver a larger amount of raw materials from the stockhouse to the furnace in a more accurate, regular, and efficient manner.[13]

ENDNOTES:

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* All cited original drawings are in the possession of U.S.X. United States Steel Division, Engineering Office, Clairton PA.

STEELMAKING PLANT - BESSEMER

Historic Name: U.S.S. Corporation, Duquesne Works: Steelmaking Plant, Bessemer Converter House.
Present Name: N/A
Location: Upper Works
Construction: 1886, 1897
Documentation: There are no photographs or drawings.

DESCRIPTION

I. There are no extant facilities from the Bessemer Converter Plant.

HISTORY

Each of the industry's major steelmaking processes - Bessemer, Open Hearth, Electric Furnace, and Basic Oxygen - have been employed at the Duquesne Works during the course of its history. When the works began operations in 1887, the acid Bessemer process was used to make steel. Essentially, the process involved blowing air up through tuyeres located in the bottom of a cylindrically shaped, acid (silicious brick)-lined, open-top converter which contained a mixture of scrap steel (approximately 10% of the charge) and a molten bath of iron. The exothermic (i.e. heat generating) reaction between the oxygen content of the air and the molten metal converted the bath of iron into a bath of steel by eliminating carbon, silicon, and manganese from the iron through oxidation. An average blow lasted approximately 15 minutes.

The Bessemer converter plant at Duquesne occupied the southern end of the present site of Open Hearth Number Two. Its physical design allowed for the most efficient operation of the process possible. Buildings and equipment were laid out in close proximity to each other so as to permit easy movement of materials. Basic features of the original Bessemer converter plant included a combination converter/blooming mill building which contained two refractory brick lined converters with a 8 1/2 ton capacity; a bottom house where the removable converter bottoms were taken to be repaired; a cupola house which contained iron remelting furnaces; a scrap storage yard; and a blowing room containing the vertical steam driven blowing engines which supplied blast air to the converters.

The converter enclosure was the center of operations. It was divided into a charging, pouring, and teeming aisle. The converters, which sat on trunnions located on the elevated charging floor, tilted in the direction of the charging aisle and the pouring aisle. Set directly over the mouth of the converter on the scrapping floor were a series of bins containing scrap steel segregated by its metallurgical composition. On the charging side of the vessels, the ground floor extended under the converters and offered space for the removal of converter bottoms and slag.

In plants such as the one at Duquesne, the process began with the removal and replacement of the converter bottom if it required repair. First, the steel plate constructed shell or wind box which covered the tuyeres was removed. Afterward, a small truck riding on rails was run out of the bottom house and positioned under the converter. Once positioned, the truck's hydraulic powered lifting table was raised up to the level of the bottom and the keys fastening the bottom to the converter were knocked out thereby allowing it to drop onto the table. After the table descended to its original position, the truck was run back to the bottom house where a crane removed the deteriorated bottom and replaced it with a reconstructed one. The procedure was then reversed and the bottom was replaced on the converter. The decayed bottom was repaired by replacing its tuyeres and relining it with refractory brick before placing it in one of the bottom house's drying ovens where the brick was carefully dried and baked for a period of 48 hours.

With the replacement of its bottom, the converter was ready to be charged. A critical element of the charging process was determining the proper amount of cold scrap and hot metal to be charged into the converter. This was regulated by the amount of and grade of steel required at the blooming mill. Important considerations in meeting the rolling requirements were the composition of the molten pig iron to be charged and the heat requirements of the blow. Molten iron, containing levels of silicon and manganese which could not be sufficiently removed by oxidization during the converter blow, was diluted by a proportioned charge of steel scrap with low levels of those elements. Because the process was dependent on heat generated by the oxidation of the impurities, a significant portion of the iron could be lost through oxidation if the heat generated by the blow exceeded the temperature required to keep the iron molten. The addition of a proportioned cold scrap charge, then, also performed the function of controlling the temperature of the heat. When the blower determined the proper mixture of molten pig iron and cold scrap, he sent an order to the cupola house for a certain weight of molten pig iron.

After the iron had been tapped from the cupola into a ladle car and weighed, it was run over to the charging floor of the converter on rails by a dinky. The converter was then turned down to a horizontal position, so as to bring the tuyeres well above the bath, and the molten iron was poured into its mouth by the slowly tipping ladle. When the molten charge was completed, the air blast, under sufficient pressure to prevent the metal from flowing into the tuyeres and also to force the air through the liquid, was turned on. The vessel was then brought to a vertical position and the scrap was added from the scrapping floor by means of a chute.

The blow occurred in three distinct stages. During the first stage, when silicon and manganese were eliminated from the charge, dense brown fumes which were shortly succeeded by a dull red, short flame protruded from the mouth of the vessel. This action lasted about six minutes. The second stage of the blow or "boil" produced the elimination of carbon from the bath which lasted for about eight minutes. During this period, the flame increased, both in length and luminosity, until it reached a length of thirty feet or more. The final stage or end point witnessed a sudden drop in the flame's length and luminosity.

After the end point had been reached, the converter was turned down into the pouring position and the blast air was turned off. While the molten steel was carefully poured into a teeming ladle, so as to prevent as much slag as possible from escaping with the steel, the metal was deoxidized and recarburized. By adding materials such as ferromanganese, spiegel, anthracite coal, ferrosilicon, and pig iron to the teeming ladle as the metal was being poured, the blower was able to control the carbon content of the steel, deoxidize it, and improve its quality. The mix of materials added during this operation was determined by the product which was about to be rolled. For example, if it was required to produce a soft steel, such as skelp for rolling pipe, hot ferromanganese was added to raise the percent of this element to .40. If the final product was to be steel rails, a molten spiegel mixture composed of spiegel, ferrosilicon, and pig iron was used as the recarburization agent.

When the pouring and its concomitant recarburization operations were completed, the converter was inverted and the slag which did not flow out with the steel was dumped onto a small flat car beneath the vessel. A jib crane then transferred the ladle to the front of the steel-framed platform at the teeming aisle where the steel was "teemed" into ingot moulds which were set on flat cars running on narrow gauge tracks alongside the platform. Teeming consisted of spotting the teeming hole in the bottom of the ladle directly over an ingot mould and raising the ladle's stopper assembly so that the molten steel could flow into it. After the ingots were teemed, they were allowed to stand and cool before they were sent to the blooming mill's soaking pits.[1]

During the period when the Duquesne Works used cupola melted pig iron, it set a world record for productivity for a two converter plant by making 38,000 tons of ingots in one month. The use of cupolas, however, entailed certain disadvantages which affected the quality of the steel produced. Because the cupolas, which operated like blast furnaces, used coke as their primary fuel, much of the sulphur and phosphorus inherent in the coke was absorbed into the iron. Their presence, which is undesirable in steel above certain limits, could not be removed by the Bessemer process. As a result, care had to be taken to use only the best coke available, in minimal amounts, when charging the cupolas. These factors, combined with the fluctuation in iron composition, caused erratic swings in iron temperatures, resulting in difficulties in controlling the blowing of the converters. Consequently, the cupolas were abandoned and hot metal was drawn directly from a 200 ton capacity hot metal mixer when the Works put its newly constructed blast furnace plant in operation.

The cylindrically shaped refractory brick lined mixer stored molten iron taken from the blast furnaces and conserved its heat by a continuous rocking motion. In addition to saving the remelting and handling costs which were associated with cupola use, the mixer improved the metallurgical composition of the iron because it was able to store several blast furnace casts at one time, thereby mixing iron low in some elements with iron that was high in the same ingredients. Thus, the hot metal delivered to the converters was of more uniform quality than could otherwise have been obtained. The design of the Duquesne hot metal mixer, moreover, represented a significant improvement over the original box mixer designed by Captain William Jones of the J. Edgar Thomson Works in 1888. Unlike the two 100 ton capacity box mixers at the Edgar Thomson Works, which were rocked by a motor driven gear and pinion arrangement, the Duquesne mixer was mounted on two sets of racers and rollers which were formed to its shape and carried the weight of the vessel. A hydraulically powered plunger, connected to the mixer by means of a link, rocked or revolved it on the rollers. As such, this design allowed for mixers of much greater capacities (up to 1300 tons) than the original box design could accommodate, making the Duquesne design the standard from which all mixers were constructed in the future.[2]

<u>ENDNOTES</u>:

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2."Duquesne Furnaces and Steel Works," <u>The Iron Trade Review</u> 30 (March 4, 1897): 8, 9; Camp and Francis, <u>The Making Shaping and Treating of Steel</u>, 268; United States Steel Company, <u>The Making, Shaping, And Treating of Steel</u>, Sixth Edition, (Pittsburgh, 1951), 383; and "The Duquesne Metal Mixer," <u>The Iron Trade Review</u> 30 (June 3, 1897): 8, 9.

STEELMAKING PLANT - OPEN HEARTH

Historic Name: U.S.S. Corporation, Duquesne Works: Open Hearth Steelmaking System
Present Name: U.S.X. Corporation, National-Duquesne Works; Open Hearth Steelmaking System
Location: Upper Works, Duquesne, Allegheny County, PA
Construction: 1900, 1908
Documentation: Photographs of the Blast Furnace Plant located in HAER No. PA-115-A.

DESCRIPTION

I. Open Hearth Number Two Mixer Building: Laid out on a north - south axis, the mixer building was built by the American Bridge Company. It is 132'-9" wide x 58'-0" long x 45'-0" high to the underside of the truss and is built on a concrete foundation. The western half of the building adjoins the southern end of the Open Hearth Number Two furnace building. The steel framed building has a gable roof and monitor which is supported by Fink trusses. Its exterior is made up of corrugated metal. Four ventilation hoods protrude up through the roof on its eastern side.
Construction date: 1909.

II. Open Hearth Number Two Stock Yard: The 60'-2" wide x 960'-0" long stock yard is laid out on a north-south axis between the eastern wall of the Open Hearth Number Two furnace building and the western wall of the BOP shop. It was constructed by the American Bridge Company. A 57'-11" wide x 28'-3" high craneway runs the length of the stock yard. It carries one American Bridge E.O.T. crane with a 10-ton capacity.
Construction date: 1908.

III. Open Hearth Number Two Furnace Building: Constructed by the American Bridge Company, and located approximately 350'-0" north of blast furnace number one, the one story, 124'-6" wide x 1005'-0" long furnace building is laid out on a north-south axis. The building's concrete foundation supports a steel framework. Its gable roof and monitor is supported by riveted Fink trusses and its exterior is made up of corrugated metal.

The building is divided into two sections, the charging aisle and the pouring aisle. The charging aisle forms the eastern half of the building and is 69'-6 1/2" wide x 1005'-0" long x 45'-0" high to the underside of the truss. A 65'-0" wide x 27'- 7 3/4" high craneway runs the length of the aisle. It carries two Alliance 110/40/20-ton capacity E.O.T. cranes. Both a wide gauge and narrow gauge track run parallel to each other through the length of the aisle.

The pouring aisle encompasses the western half of the building. It is 54'-11 1/2" wide x 1005'-0" long x 57'-0" high to the underside of the truss. Running the length of the aisle is a 49'-6 1/2" wide x 39'-9 1/2" high craneway. It carries three Alliance 200/50 ton capacity E.O.T. cranes and one Morgan 200/50 ton capacity crane. Located along the wall of the aisle (eastern wall of the building) are three steel framed teeming platforms. A narrow and a standard gauge track running parallel to each other alongside the teeming platforms extends the length of the building.

Several ladles and scrap ingots are located at the northern end of the building. Several spare parts storage bins are located near the southern end of the charging aisle.
Construction date: 1908.
Construction of 45'-0" extension to accommodate one electric furnace at the northern end of building: 1916.

IV. <u>Open Hearth Number Two Mould Preparation Building</u>: The one story, 49'-0" wide x 882'-0" long steel framed mold preparation building adjoins the eastern wall of the furnace building. Built by the American Bridge Company on a concrete foundation, the building has a corrugated metal exterior. Wide-flanged I-beams support the building's sloped roof and its seven rectangular box monitors. A 44'-10" wide x 29'-0" high craneway runs the length of the building. It carries two 10-ton capacity E.O.T. cranes. A hot topping steel framed platform is located along the eastern wall of the building near its southern end. Two parallel narrow gauge tracks extend the length of the building.
Construction date: 1908.

V. <u>Open Hearth Office Building</u>: Built by the American Bridge Company, the building is located between the Open Hearth Number Two furnace building and the BOP shop at their northern end. The 25'-3" wide x 39'-7" long x 22'-1" high brick building is composed of a basement and two stories. Two rows of dormer windows rim the building. An entrance way is located on its western wall. Its hipped roof is constructed of slate.
Construction date: 1910.

HISTORY

Beginning with the construction of a basic open hearth steelmaking plant (Open Hearth Number One) at the turn of the century, the Duquesne Works gradually shifted from the acid Bessemer to open hearth production. In short, the basic open hearth process involved the burning of a mixture of gas and air over a charge of limestone, iron ore, scrap steel, and molten pig iron contained within a rectangular, magnesite refractory brick-lined regenerative furnace. The oxygen content of the air, the limestone and the iron ore transformed the iron into steel by eliminating carbon, silicon, manganese, sulphur, and phosphorus from the molten bath by means of oxidation.

The use of the open hearth process had several advantages over the acid Bessemer process. Because the process used iron ore as a oxidizing agent and because heat was applied externally, the temperature of the bath was made independent of the purifying reactions and the impurities were eliminated gradually so that the temperature and composition of the molten bath was under much better control. For the same reasons, a greater variety of raw materials could be utilized, particularly scrap which was not readily consumable in the Bessemer converter, and a greater variety of products could be made. This was particularly significant at Duquesne which became an important producer of alloy steel bars for the eastern market in the United States. Another important advantage of the basic open hearth process was the increased yield of finished steel from a given quantity of pig iron, because of lower inherent iron losses and because of the recovery of the iron content of the ore used for oxidation. Finally, the greatest advantage of the open hearth over the Bessemer process was its ability to eliminate phosphorus and sulphur from the bath. This opened up vast quantities of American iron ore deposits high in phosphorus content for use in steelmaking.[1]

Open Hearth Number One was located on the present site of the basic oxygen steelmaking facility. Like the Bessemer plant, its structures and equipment were laid out in such a manner as to permit a smooth and easy flow of materials. Open Hearth Number One initially consisted of a stockyard, a furnace building, a cinder yard, a skull cracker, and a mould conditioning building. The furnace building, which was the center of activity, had split level floors with the floor of the charging aisle located 9'-0" above the floor of the pouring aisle. Twelve 50-ton capacity stationary open hearth furnaces, laid out linearly, divided the building between the charging and pouring aisles. Along the wall of the pouring aisle, opposite the furnaces, stood the teeming platform.

The process began with the proportioned loading of scrap and raw materials boxes set upon flat rail cars in the stockyard which adjoined the furnace building. The proportions of scrap and raw materials used depended upon the desired grade of steel. When loading was complete, the cars were run along a narrow gauge track by a dinky to the charging floor of the furnace building and deposited alongside one of the furnaces. A Wellman-Seaver charging machine running on wide gauge track adjacent to the boxes and equipped with a hydraulically operated arm or "peel" picked the boxes up in sequence and overturned them into the furnace hearth through its water-cooled charging doors. Limestone was charged first, followed by iron ore and finally the scrap. The entire mass was heated for approximately two hours, or until the scrap was white hot and slightly fused, by burning natural gas mixed with combustion air over it. During the period in which the furnace operated, waste gas and combustion air were passed alternatively through the furnace's regenerative heating chambers every twenty minutes. Constructed of brick checkerwork, the regenerative chambers were located below the structural charging floor and away from the furnace.

When the initial charge was ready, a ladle full of molten pig iron, drawn from the mixer at the Bessemer plant, was transported by an E.O.T. crane and charged into the furnace through a spout inserted into the charging door. Soon after the molten iron had been charged, a reaction occurred in which almost all of the silicon, manganese, phosphorus, sulphur, and part of the carbon was eliminated. All of these materials except the carbon, which escaped as carbon monoxide and caused an agitation of the bath, became part of the slag. During the next two or three hours, about 80 percent of this slag flushed into a slag pot through a notch located in the back of the furnace. The iron ore then entered a three to four hour period known as the "ore boil" during which it reacted with the carbon. Then, for approximately two or three hours carbon dioxide emitted from the limestone as it was being decomposed by the heat bubbled through the bath and exposed part of the metal to the flame, thus oxidizing it. Known as the "lime boil," this activity completed the purification begun by the ore reaction and left the carbon content of the bath somewhat greater than that at which the metal was to be tapped. If, after a sample of the molten metal was taken, it was determined that the carbon content was too high or too low, more pig iron or iron ore was added. In any case, after about another hour the carbon content was reduced to the proper level for tapping. The temperature of the bath at tapping was in the neighborhood of 3000° F., varying according to the composition and grade of the steel.

Tapping began with the digging out of the clay-loam plug and dolomite used to seal the tap hole before the furnace was charged. Molten steel escaped from the tapping hole, which was located at the lowest level of the hearth, into a teeming ladle through a removable spout. The ladle was set on a stand below the tapping hole in a shallow ladle pit by an E.O.T. crane. Owing to the position of the tap hole, the greater portion of the steel flowed out of the furnace before slag appeared in the spout, thus allowing time for the addition of alloying, recarburizing, and deoxidizing materials into the ladle as it filled up with molten steel. The remaining slag was directed into an adjacent cinder pot through a spout attached to the ladle after a sufficient depth of slag covered the steel for protective purposes. As soon as the slag removal was complete, the ladle was removed from its supporting stand and conveyed by an E.O.T. crane to a position over the ingot moulds located next to the teeming platform, while the slag was dumped in the cinder yard. After teeming was complete, the ladle was conveyed to the skull cracker where a large steel ball attached to a E.O.T. crane knocked solidified steel off the lip and sides of the teeming ladle in much the same manner as a wrecking ball is utilized to demolish a building.[2]

Duquesne dramatically expanded its open hearth facilities in the years immediately following the construction of Open Hearth Number One. Between 1902 and 1907, eight furnaces (two 50-ton capacity and six 60-ton capacity) were added to Open Hearth Number One's facility. In 1908, Bessemer production was abandoned and construction of a new basic open hearth plant (Open Hearth Number Two) began on the site of the Bessemer/blooming mill complex. The new plant, which was built along the same lines as Open Hearth Number One, was equipped with twelve 60-ton capacity stationary furnaces. In addition, a mixer building for each plant, a gas producer facility, and a calcining plant was added. A 300 ton capacity mixer was installed in each mixer building. The gas producer building, which contained 32 furnaces, was built between the furnace buildings of Open Hearth Number One and Number Two. It generated gaseous fuel for each open hearth plant by forcing air and steam up through a bed of coal located in the hearth of the refractory brick-lined furnaces. The resulting carbon monoxide given off by the incandescent coal was directed through flues to the burners of the open hearth furnaces. The calcining plant contained cupolas which were used for roasting dolomite. The calcined dolomite was subsequently used to repair the banks and bottoms of the open hearth furnaces.[3]

Between 1908 and the shutdown of open hearth steelmaking at Duquesne in 1965, there were a number of significant changes to the system. The installation of coke oven gas lines from the Clairton Works in 1918, for example, gave the open hearth furnaces the added capability of utilizing another fuel besides natural and producer gas. The period also witnessed a number of furnace rebuilds which steadily increased furnace capacity. By

1951, each of the furnaces at Open Hearth Number One had a capacity of 90 tons, while those at Open Hearth Number Two each had a capacity of 145 tons. Finally, between 1951 and 1954, changes with respect to improved furnace design and fuel usage resulted in a significant reduction of heat times. Among the most important design improvements was the replacement of acid by basic refractory brick-lined furnace roofs and ends. Acid-lined furnace roofs and ends limited the temperature at which the furnace could be fired because of their inability to withstand high temperatures without decomposing. The construction of two 4,000,000 gallon capacity storage tanks, moreover, made it possible to regularly augment whatever fuel was being burned in the furnaces with number six fuel oil. By atomizing the fuel oil with steam at the furnace burners, operators were able to adjust the character of the flame in such a manner as to increase its emissivity (or radiation intensity) while decreasing total fuel consumption at the same time. As a result, heat times were reduced from an average of 12.6 hours in 1950 to 10 hours in 1954, while fuel consumption was reduced by 9 percent.[4]

ENDNOTES:

1.J. M. Camp and C. B. Francis, The Making, Shaping, and Treating of Steel, Fourth Edition, (Pittsburgh, 1924), 200; United States Steel Corporation, The Making, Shaping, and Treating of Steel, Sixth Edition, (Pittsburgh, 1951), 401; United States Steel Corporation, "Duquesne Works - Steel Production Conference," Tms, 1951, 41.

2."The Open Hearth Plant and 40-Inch Blooming Mill of the Carnegie Steel Co., at Duquesne, Pa.," The Iron Trade Review 36 (January 1, 1903): 84, 85; "The Duquesne Works of the Carnegie Steel Company: The Open Hearth Plant and the Blooming and 14-Inch Morgan Continuous Mills," The Iron Age 71 (January 1, 1903): 12-14; Camp and Francis, 290-93; and The Making, Sixth Edition, 401, 448-49.

3.Carnegie Steel Company, "Duquesne Works: Plant Description Book," (Duquesne, 1925), 47, 50, 51, 58, 59; "Open Hearth Installation at Duquesne Completed - Bessemer Converters Replaced," The Iron Trade Review 45 (August 5, 1909): 242; Carnegie Steel Company, "Section Through 60 Ton Open Hearth Furnaces, Stock Yard No. One, & Gas Producer Building: Drawing #8793, August 1, 1911."; "Section Through Mould & Cinder Yard Number Two, Open Hearth Plant Number Two, Stock Yard, and Gas Producer Plant: Drawing #9050, December 15, 1912."; "Upper Works - Duquesne, PA - Tracks and Equipment: Drawing #12960, April 20, 1923"; and Camp and Francis, 73, 74, 293.

4."U. S. Steel Shuts Down Duquesne Open Hearths," Blast Furnace and Steel Plant 53 (October 1965): 959; Williams Brothers Company, "Preliminary Engineering Report on Clairton - Homestead Coke-Oven Gas Pipelines," (Tulsa, 1956), 2; United States Steel Company, "Duquesne Works -Steel Production Conference," Tms, 1951, 4-6; "Location Second 4,000,000 Gallon Fuel Oil Storage Tank: Drawing #25302, October 10, 1951."; Bruce Shields, "Combustion in the Open Hearth Furnace," Tms, 1952, 4, 5; United States Steel Corporation, "Operating Statistics, Duquesne Works, 1950-1954," Tms, 4; Bruce Shields, former Chief Metallurgist at the Duquesne Works and former Director of Metallurgical for the United States Steel Corporation, Interview with author, July 10, 1990.

STEELMAKING PLANT - ELECTRIC FURNACE

Historic Name: U.S.S. Corporation, Duquesne Works, Electric Furnace Steelmaking System
Present Name: U.S.X. Corporation, National-Duquesne Works, Electric Furnace Steelmaking System
Location: Lower Works
Construction: 1943, 1957
Documentation: Photographs of the Electric Furnace can be found in HAER No. PA-115-C.

DESCRIPTION

I. Electric Furnace Building and Lean-to:

The electric furnace building is located at the northern end of the lower works near its far western side. Constructed by the American Bridge Company and laid out on a north-south axis, the steel framed building is 237'-0" wide x 897'-2" long x 77'-0" high to the underside of the truss. It has a corrugated metal exterior with louvers on all four walls. The stock house aisle of the building has a slightly pitched roof which is supported by riveted Pratt trusses. A gable roof supported by riveted Warren trusses with riveted I-beam bracing extending downward from the underside of the roof to the top chord of the truss covers the charging and pouring aisles. A 15'-0" wide x 450'-0" long x 12'-0" high lean-to is built onto the eastern wall of the building.

A. Stock House Aisle: The 82'-0" x 460'-2" long stock house aisle is located on the western side of the building. It consists of two floors. The ground floor covers the entire aisle while the second or scrap make-up floor consists of a 29'-6" extension of the charging floor on the eastern side of the aisle. Running the length of the aisle, the scrap make-up floor is located 20'-0" above the ground floor. It carries two parallel narrow gauge tracks. The outside track runs outside of the southern end of the building and alongside the outside western wall of the charging aisle on a 18'-0" wide x 195'-0" long trestle extension of the floor. The total space occupied by the scrap makeup floor and its extension provides sufficient space for forty-three charging-box cars.

Laid out along the western wall of the aisle on its ground floor are eighteen 25'-0" square x 5'-0" high scrap stock bins. Two standard gauge railroad tracks run through the center of the aisle for its entire length. Located on the ground floor, 32'-0" from the southern wall of the aisle along its eastern side is a 20'-0" wide x 26'-0" long x 17'-0" high maintenance shop constructed of brick. A 25'-0" wide x 31'-7" long x 17'-0" high air compressor room made of brick construction is adjacent to the maintenance shop at its southern end. Several pallets of refractory brick lay on the floor near the southern end of the aisle. The aisle is serviced by two Morgan E.O.T. cranes with a capacity of 25 tons.

B. Charging Aisle: The 80'-0" wide x 785'-2" long charging aisle makes up the middle bay of the building. It extends 325'-0" farther south than the stock house aisle and is composed of two floors, the ground floor and the charging floor. Located on the ground floor, 430'-0" from the southern wall of the aisle and laid out on a north-south axis, is a 35'-0" wide x 100'-0" long x 17'-0" high 6600 volt indoor sub station constructed of brick. The station contains control panels for all of the electrical equipment located in the electric furnace building. Several overhead charging buckets with 50-ton capacities are stored on the ground floor near the southern end of the aisle.

The charging floor is made up of a 80'-0" wide x 20'-0" high steel framed platform. It extends from the northern wall of the aisle for a distance of 556'-0". Located along the western side of the floor near its mid-point is the melters office. Constructed of sheet steel, the office is 15'-0" wide x 22'-0" long x 8'-0" high and is flanked by four 25'-0" x 7'-6" high ladle alloy addition stock bins on its northern and southern side.

Running down the center of the floor on a wide gauge track for its entire length are two 7 1/2-ton capacity Alliance side door charging machines. The machines travel by means of a electrically powered rail located on the western side of the aisle.

The eastern side of the floor is made up five magnesite brick-lined electric furnaces and their transformer houses. All of the tooth rocker-type furnaces were constructed by the American Bridge Company. The southern most furnace (X-5) is located 283'-6" off the south wall of the aisle. It has a capacity of 85 tons and is top charged. A 25,000 kva transformer services the furnace. Furnace X-1 is located 64'-0" due north of X-5. The top charged furnace has a capacity of 20 tons. It is serviced by a 6000 kva transformer. Located 180'-0" north of furnace X-1 is furnace X-4. Side door charged, the furnace has a capacity of 85 tons and is serviced by a 22,500 kva transformer. Furnace X-3 is located 60'-0" north of furnace X-4. It has a capacity of 85 tons and is side door charged. A 22,500 kva transformer services the furnace. Located 83'-0" north of furnace X-3 is furnace X-2. The side door charge furnace has a capacity of 45 tons and is serviced by a 12,500 kva transformer. All of the cable and bus bars connecting each electric furnace to its transformer has been severed. Although the electrode holders for each furnace are in place, there are no graphite electrodes on the site. Located several feet north of furnace X-2 is a small sheet steel constructed control room for the vacuum degassing pits on the pouring aisle floor. The aisle is served by three E.O.T. cranes. A 75-ton crane serves the southern end of the aisle. A 125-ton and a 25-ton crane serves the charging floor.

C. Pouring Aisle: The 75'-0" wide x 647'-2" pouring aisle is located on the eastern side of the building. It extends 75'-0" farther south than the stock house aisle and 112'-0" farther north than the stock house and charging aisles. The aisle makes up the ground floor of the eastern bay. Located below the pouring spout of each furnace on the western side of the aisle is a wide gauge track laid out on a east-west axis between 10'-0" high splasher walls. The track carried a transfer car which positioned slag pots below the furnace on its western side. Laid out on a north-south axis and located near the southern wall of the aisle on its western side is a 14'-0" wide x 46'-0" long x 18'-0" deep ladle repair pit capable of servicing three ladles at a time. Two ladle stands, one located between furnaces X-3 and X-4 and one located just north of furnace X-5, also exist on the western side of the aisle. Finally, the western side of the aisle contains three vacuum degassing casting pits. The northern most pit, located 40'-0" south of the northern wall of the aisle, is 17'-0" wide x 45'-0" long x 24'-5" deep. A 25'-0" wide x 85'-0" long x 24'-5" deep vacuum degassing pit is located 37'-0" south of the northern most pit. The third vacuum degassing pit is located 17'-0" north of the ladle repair pit. It is 18'-0" wide x 25'-0" long x 24'-5" deep.

Running for nearly the entire length of the eastern side of the aisle is a 7'-9" high steel framed teeming platform. A narrow gauge track, set upon the floor alongside the platform, runs through the building. The teeming platform extends into the lean-to.

A 34'-0" wide x 56'-0" long x 10'-0" high bag house is located between the eastern outside wall of the electric furnace building at its southern end and the western outside wall at the northern end of the steel conditioning building on an approximately 30'-0" high steel framed platform. It has a gable roof and continuous ventilator.

Original construction date of building: 1943.

Construction of 325'-0" extension to southern end of charging aisle: 1957.

Construction of 112'-0" extension to northern end of pouring aisle: 1957.
Installation of original equipment: 1943.
Installation of vacuum degassing equipment: 1956 - 1960.
Installation of baghouse: 1960.

II. Electric Furnace Office Building and Chemical Laboratory:

Laid out on a north-south axis, the three story, 41'-9" wide x 88'-4" long brick building is located just north of the electric furnace building. The eastern end of the building (approximately 15'-0") extends into, and is accessible from, the charging aisle of the electric furnace building. Dormer windows rim the first two stories of its eastern, western, and northern walls. A row of dormer windows is also located on the third story of the northern wall. The first two floors of the building contains offices, while its third floor houses a chemical laboratory.
Construction date: 1943.
Construction of 26'-0" extension to southern end: 1956.

III. Steel Conditioning Building:

Constructed by the American Bridge Company, the steel-framed building is 85'-0" wide x 500'-0" long x 42'-0" high to the underside of the truss. The building is located 33'-0" east of the electric furnace building and is laid out on a north-south axis. Its northern end (approximately 40'-0") runs parallel to the southern end of the electric furnace building. The building's gable roof and continuous ventilator is supported by riveted Pratt trusses. It has a corrugated metal exterior. A standard gauge railroad track runs through the building on its eastern and western side. The single bay building is serviced by two 25-ton E.O.T. cranes, spanning its width.

One electrically powered mobile Mid-Western grinder runs on rails along the eastern and the western inside wall of the building at its northern end. A 17'-0" wide x 300'-0" long x 12'-0" high steel-framed hot topping ingot mould platform runs along the inside eastern wall of the building at its southern end.

Two 15'-0" wide x 25'-0" long x 12'-0" high corrugated metal lean-tos are built onto the outside eastern wall of the building near its northern end. Each lean-to houses a large motor, and fan which draws fumes from the steel conditioning building into a ventilation hood protruding through its roof.
Construction date: 1943.
Construction of 75'-0" extension to its southern end: 1957.

IV. Steel Conditioning Office, and Storage Building:

Laid out on a north-south axis and built onto the eastern outside wall of the building at its southern end is a 18'-0" wide x 220'-0" x 12'-0" high long brick lean-to. The building houses the steel conditioning office, the grinder storage room, the tool storage room, locker room, and wash room.
Construction date: 1943.

V. Outdoor Electrical Sub-Station:

Laid out on a north-south axis, a 140'-0" wide x 270'-0" long sixty-nine kv sub-station is located 70'-0" north of the steel conditioning building and 42'-0" east of the electric furnace building. A one story, 20'-0" wide x 30'-0" long control building is located in the northeast corner of the sub-station.
Construction date: 1943.

HISTORY

Electric furnace steelmaking at Duquesne began in 1917 with the installation of an Heroult 20-ton tilting furnace in the furnace building of Open Hearth Number Two. Located at the northern end of the building in line with the open hearth furnaces, the electric furnace was serviced by existing auxiliary equipment. It originally was used only for deoxidizing and desulphurizing basic open hearth steel. Many special alloy open hearth heats were finished in this manner because the electric furnace made it possible to produce a more homogeneous product.

The process began by teeming a ladle of molten steel from an open hearth heat into the charging ladle of the electric furnace. The charge was then transported by a dinky running over a narrow gauge track to the furnace where it was poured through a portable spout attached to the water cooled charging door of the furnace. As the charge was being poured, a sample of it was taken for chemical analysis in order to determine the proper amount of carbon (in the form of anthracite) and manganese to be added. After analysis, the materials were added to the furnace as the pouring was completed. With the completion of charging, the furnace's three graphite electrodes were adjusted to a point just above the bath and the current was turned on.

The bath was heated by the direct arc method. That is, the current was passed through an electrode into the bath and back from the bath to the next electrode. Because the charge initially froze over the top, especially in low carbon steels, nothing was done until it was completely melted. When melted, a slag mixture consisting of four parts lime and one part fluorspar or clean sand was added. Several samples of the slag were taken in the period after the mixture was added. As the heat proceeded, the color of the slag samples taken varied between shades of brown, and contained varying amounts of manganese oxide, indicating the stage of deoxidation or levels of iron oxide being reduced. A slag sample which was decidedly brown in color meant that deoxidation was well under way. At this point a second slag mixture consisting of proportioned amounts of lime, fluorspar, sand, and coke dust was added to the bath. The addition of this mixture made the slag less vitreous thereby creating a tendency for it to slake or disintegrate. At the same time the color of the slag began to fade. Deoxidation was judged complete and preparations were made to finish the heat when a sample of the slag disintegrated upon becoming cold, while the color turned gray.

The heat was finished by adding whatever alloys were required in the batch. In order to give these alloys time to thoroughly mix with the steel, a period of approximately thirty minutes was allowed to pass before the heat was tapped. After a final sample was taken to determine if the condition of the slag was satisfactory, the furnace was tapped. Tapping consisted of tilting the furnace on its rockers toward a teeming ladle set in a pit below the tapping spout on the pouring aisle of the building. A special skimmer, attached to the pouring spout of the furnace, separated the slag from the steel as it was being poured into the ladle. Subsequent to tapping, the ladle was carried over by a E.O.T. crane to the platform where the steel was teemed into ingot moulds.[1]

Full fledged use of the electric furnace process for melting down steel scrap did not take place at Duquesne until World War II when an alloy steel plant was built by the Defense Plant Corporation (D.P.C.). The new facility, which was part of an effort to increase production for war time needs, was designed to work in conjunction with a newly constructed heavy forging plant built by the D.P.C. at the nearby Homestead Works. Consisting of electric furnace, heat treating, and steel conditioning facilities, part of the plant was built on land occupied by the city of Duquesne's First Ward, which had been located between the upper and lower works. The electric furnace building originally contained two side door charged 70-ton furnaces and one side door 35-ton capacity furnace. All of the furnaces contained a basic (magnesite brick) lining.

Electric furnace alloy steelmaking at Duquesne followed the precepts of the "cold melt process." The process employed the direct arc method and was conducted in two stages. During the first stage or oxidizing period, a charge of cold scrap steel was melted down and impurities were subsequently eliminated from the bath. The second stage, or reducing period, involved creating the required alloy composition in the steel.

The process began with the loading of scrap boxes on the ground floor of the stockhouse aisle. After each box was loaded and weighed, it was lifted up by an E.O.T. crane and set on one of several flat cars located on the scrap makeup floor. The line of cars were subsequently moved by a Diesel locomotive over crossover tracks to the charging floor where they were set alongside the furnaces to be charged. Each box was picked off of its respective car by the peel of the charging machine and overturned inside of the furnace through its water cooled charging door. A thin layer of light scrap was charged first, followed by heavy scrap, which was placed within or adjacent to the triangle or "delta" formed by the electrodes. Finally, light scrap was piled high around the sides of the furnace in order to protect the roof and side walls from the arc during the high power melt down period.

When the charging operation was complete, the electrodes were adjusted into place and the current was turned on. Melt down usually lasted for three and one-half or four hours, after which the silicon, manganese, phosphorus, and carbon contained in the scrap was oxidized, forming a slag which floated on top of the molten metal. This part of the process lasted for about one hour. As soon as the oxidizing period was complete, the electrodes were raised and the current was shut off while the slag was manually raked off the bath by the manipulation of long stemmed wooden "rabbles" put through the charging door. During this period, the furnace was tilted backward to permit the slag to drain into a cinder pot located on the transfer car running between the splasher walls. Completion of slag removal made the heat ready for the reducing stage of the process.

The reducing period began with the addition of a new slag mixture, composed of burnt lime, fluorspar, silica sand, and powered coke, to the bath. Before adding the components of the new slag mixture into the furnace, the charging machine placed their individual charging boxes into a gas fired drying oven located on the charging floor, in line with the furnaces. Powdered coke, which was added to the slag after it became fluid, supplied the carbon for the formation of calcium carbide. The presence of calcium carbide in the slag facilitated the removal of sulphur from the bath and allowed for the addition of alloys such as manganese, nickel, chromium, vanadium, and tungsten to the molten metal because it returned their reducible oxides from the slag to the bath. After a period of approximately two hours or when a sample of the molten metal indicated that its composition met the requirements of the heat, the power was turned off and the final deoxidation additions, such as aluminum, were made. At this point, the furnace was tilted forward on its rockers and its tap hole was opened. Due to the elevation of the tap hole, the molten metal flowed out of the furnace before the slag. It was tapped into a 40 or 80-ton teeming ladle, which was spotted under the tapping spout by an E.O.T. crane. After the steel was tapped, the slag was dumped into a cinder pot and the ladle was conveyed across the pouring aisle to the platform where the steel was teemed into ingot moulds. The moulds were prepared for teeming at the southern end of the platform.

If the solidified ingots were slated to be rolled into bars, the moulds were delivered by rail to the work's primary mill where the ingots were stripped and charged into soaking pits. If the ingots were slated to be forged into armor plate, they were delivered to the forging plant at the Homestead Works.[2]

Significant changes to the steelmaking process at the electric furnace facility were made shortly after the war and continued until the mid 1970s. Among the earliest of these changes was the use of iron ore and gaseous oxygen in the production of stainless steel. By adding these elements to the process, the men who operated the facility were able to produce a lower cost, quality product at a faster pace. Iron ore was added to the furnace with the initial charge because it was beneficial in starting the oxidation of the silicon and manganese during the early stages of melt down and because it provided a cheap source of iron. When approximately 75 percent of the charge had been melted, an oxygen lance, which was connected to the work's dri-ox piping system, was inserted into the slag-metal interface of the bath through the wicket holes on the charging door. The plastic refractory coated lances delivered 10,000 to 12,000 cubic feet of oxygen per hour to the bath under a pressure of 110 psi. Subsequent to the beginning of the oxygen blow, the electrodes were often raised and the melting was completed with the exothermic heat of the oxygen reaction, significantly saving power costs. The reaction of the oxygen with the silicon in the bath, moreover, quickly raised its temperature above that required to reduce the carbon content, even though unmelted scrap remained around the banks of the furnace. As a result, elimination of the carbon had proceeded so far by the time the charge was completely melted that the additional time necessary to reduce the carbon content to the requirements of the heat was greatly decreased.

The use of oxygen in electric furnace steelmaking also provided a measure of flexibility to the system. If, for example, a power failure occurred during the reducing stage of the heat, oxygen could be used to shape the reducing slag and melt all alloy additions prior to tapping.[3]

A very important addition to the teeming process occurred in 1956 with the installation of a vacuum degassing or casting unit. The first such unit employed in the United States, it prevented the formation of gas (especially hydrogen) generated internal defects such as cavities and fissures in heavy forging ingots. This made it possible, for example, to produce ingots which could be forged at the Homestead Works into rotors for large electric generators. Because of the high speed at which such rotors spun, they were subjected to unusually severe stress. Consequently, the internal structure of the steel was of critical importance to the successful operation of turbines.

The unit consisted of a 17'-0" diameter x 31'-0" high pouring chamber complete with a retractable roof which was set into a pit located at the southwestern end of the pouring aisle. The base, roof, and cylinder sections of the chamber were sealed by heavy rubber rings. An aluminum diaphragm sealed the pouring port, which was located on the roof of the chamber. Air was removed from the pouring chamber by four nearby vacuum pumps.

The vacuum casting process began by setting an ingot mould upon the base of the chamber. Ingot moulds as large as 95" in diameter with a capacity of 360,000 lbs. were often teemed in this manner by successively tapping all three electric furnaces while the casting process was conducted. After the ingot mould was put into place, the retractable roof was closed and sealed. The vacuum pumps then removed the air from the chamber and a teeming ladle of molten metal was picked up by a E.O.T. crane and set over the pouring spout. As the steel began to flow from the bottom of the teeming ladle, the aluminum diaphragm was melted, allowing the molten metal to pour in the form of countless droplets into the mould. The process was monitored by a closed circuit television hook-up during the teeming period and the chamber was kept airtight by the continued use of the vacuum pumps. When the monitor indicated that the teeming process was complete, the vacuum in the chamber was broken and the ingot was removed. It took at least two days for the largest ingots to cool before they could be further processed.[4]

Between 1957 and 1960, the electric furnace plant underwent a major expansion. Each of the original electric furnaces were rebuilt and enlarged. The two 70-ton furnaces were enlarged to 85 tons and their 35-ton capacity counterpart was enlarged to 45 tons. In addition, the 20-ton electric furnace located in the furnace building of Open Hearth Number Two was reconstructed to accommodate roof charging, and was moved to the D.P.C. facility. A new, roof charged, 85-ton furnace was also constructed in the D.P.C. building. In order to facilitate the new furnaces, a 325'-0" addition to the charging aisle was constructed at the southern end of the building, and the mould conditioning platform located along the eastern wall of the pouring aisle's southern end was converted to a teeming platform. A new mould conditioning platform was built at the southern end of the adjacent steel conditioning building. At the same time, a 112'-0" addition to the pouring aisle was constructed at the northern end of the building to accommodate the installation of two more vacuum degassing units. An important result of the expansion was that it enabled the casting of 110" diameter heavy forging ingots weighing 480,000 lbs. This was done by successively tapping heats from the three largest furnaces while the casting process was in operation.[5]

The last of the major changes to the electric furnace steelmaking system at the Duquesne Works occurred between 1960 and the early 1970s with the installation of air pollution control equipment. In 1961, a smoke filtering system was introduced at the electric furnace plant. Developed by the Corporation's engineering and research division in Monroeville, PA, the equipment operated much like a giant vacuum cleaner. Smoke, in theory, from all of the plant's five electric furnaces was drawn up through a fume-collecting hood located near the roof of the building by a large fan and pushed through a rough gas main by a blower into a bag house. Thirty foot long fiber glass fabric bags filtered out the solid particles from the smoke and the cleaned gas was exhausted through flues protruding through the roof of the bag house. Dust collected in the filter bags was periodically removed by collapsing the bags in individual compartments while the other compartments continued to operate. The accumulated particulate was trucked from the plant to a storage area.

The installation of the aforementioned smoke control equipment, however, was of limited success. The continued presence in the local environment of a large percentage of untreated smoke emitted from the electric furnaces prompted local environmental groups to conduct a protest campaign against plant officials in the late 1960s and early 1970s. Partly as a result of their activities, the Allegheny County Department of Development reached an agreement with the Corporation for the installation of additional equipment. County officials agreed to finance the purchase of additional baghouse equipment through municipal bonds. For its part, the company agreed to install the new equipment and lease it from the county. The new system was put into operation in 1972.[6]

ENDNOTES:

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4."Duquesne Works Installs Vacuum Casting Process," U. S. Steel News 21 (July 1956): 43; "Vacuum Castings Made at Duquesne Works," Blast Furnace and Steel Plant 45 (December 1957): 1455; "Duquesne Works to Cast 480,000 lb. Ingot," Blast Furnace and Steel Plant 47 (January 1959): 50.

5.United States Steel Corporation, "Five Furnace Shop Layout-Step 1-325'-0" Extension South-112'-0" Extension North-Electric Furnace Building-Electric Furnace Plant: Drawing #28771, March 8, 1957."; "Add Electric Furnace at Duquesne Works," Iron and Steel Engineer 35 (April 1958): 170-1; "Add Electric Furnace at Duquesne Works," Iron and Steel Engineer 36 (January 1959): 167; "Duquesne Works to Cast 480,000 lb. Ingot", 50.

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STEELMAKING PLANT - HEAT TREATMENT

Historic Name: U.S.S. Corporation, Duquesne Works, Heat Treatment Plant
Present Name: U.S.X. Corporation, Duquesne Works, Heat Treatment Plant
Location: Lower Works
Construction: 1943, 1962
Documentation: Photographs of the Heat Treatment Plant are located in HAER No. PA-115-H.

DESCRIPTION

I. Heat Treatment Plant Building: Located parallel to and just west of the 22" Bar Mill Building, the Heat Treatment Building is 634' long x 250' wide x 42' high. The riveted steel-framed, corrugated metal building was built upon a concrete foundation by the American Bridge Company. Its gabled roof and monitor are supported by riveted Fink trusses. The building is laid out in two directions. At the northern end of the building is a 90' wide transfer bay, extending in an east-west direction across the entire 250' width of the building. It houses a 30' high craneway which carries two 25-ton E.O.T. cranes. The cranes were used to transfer bars to one of nine heat treating furnaces which are laid out parallel to each other from east to west in the two production bays located just south of and adjacent to the transfer bay. Each production bay is 125' wide x 544' long and is serviced by two 25-ton E.O.T. cranes. The furnaces themselves each run in north-south direction.

A. Car Bottom Furnace No. 1: Manufactured by the Gas Machinery Company of America (Cleveland,Ohio), this gas-fired batch furnace is located approximately 20' off of the eastern inside wall of the building, just south of the transfer bay. Approximately 30' long x 10' wide x 15' high, the furnace was used to anneal bars up to 25' long.
Installation date: 1943.

B. Car Bottom Furnace No. 6: Also manufactured by the Gas Machinery Company of America, Car Bottom Furnace No. 6 is located about 20' west of Car Bottom Furnace No. 1 and runs parallel to it. Used to anneal bars up to 36' in length, the batch furnace is approximately 50' long x 10' wide x 15' high.
Installation date: 1962.

C. Continuous Electric Heat Treating Line: Manufactured by the General Electric Corporation, the Continuous Electric Heat Treating Line is approximately 20' west of Car Bottom Furnace No.

6. Laid out linearly from north to south, the seven chamber roller type unit operated on 209 kilowatts and was used to harden and temper bars up to 25' long from 3/8" to 8 1/4" in diameter. The entire installation is 366' long. It consists of a motor powered entry table; a preheating, intermediate, and high temperature heating furnace, each 29' long x 4'-6" wide x 7'-3" high; a 29' long x 4'-6" wide x 10' deep oil or water quench tank serviced by a quench table suspended from the quench drive platform by means of cable, pulley, and drum arrangements; a 29' long x 5'-6" wide x 7'-3" high strain relief furnace; a transfer table and cradle; a preheating, intermediate, and high temperature tempering furnace, each 29' long x 5'-6" wide x 7'-3" high; and a motor powered run-out table with cradle.

Installation date: 1943.

D. Car Bottom Furnace No. 2: Manufactured by the Gas Machinery Company of America, this furnace is located about 20' west of the Continuous Electric Heat Treating Line. It is of the same approximate dimensions and serves the same purpose as Car Bottom Furnace No. 6.

Installation date: 1943.

E. Car Bottom Furnace No. 3: Located about 20' west of Car Bottom Furnace No. 2, this furnace was built by the same manufacturer to the same approximate dimensions and for the same purpose as Car Bottom Furnace No. 6.

Installation date: 1943.

F. Car Bottom Furnace No. 4: Located about 40' west of Car Bottom Furnace No. 3, this furnace fits the general description of Car Bottom Furnace No. 1.

Installation date: 1943.

G. Car Bottom Furnace No. 5: Located approximately 10' west of Car Bottom Furnace No. 4, this furnace fits the general description of Car Bottom Furnace No. 1.

Installation date: 1943.

H. Continuous Gas-Fired Heat Treating Line: Manufactured by Salem Brosius Inc., the Continuous Gas-Fired Heat Treating Line is located approximately 15' west of Car Bottom Furnace No. 5. Laid out linearly from north to south, the four chamber roller type furnaces were used to harden and temper bars up to 9' in diameter and 40' long. The line consists of a motor powered entry table, a 47'-10" long x 10'-5" wide x 8' high heating furnace; a holding furnace of the same dimensions as above; a 46'-6" long x 12'-3" wide x 14'-2" deep water quench tank serviced by a quench table suspended from the quench drive platform by means of cable, pulley, and drum arrangements; a

intermediate transfer table and cradle; a draw furnace of the same dimensions as the heating and holding furnace; a draw-holding furnace of the same dimensions as above; and a run-out table with cradle.
Installation date: 1962.

I. Ajax Mangnethermic Induction Line: Manufactured by Ajax Inc., the mangnethermic induction line was also used to harden and temper bars. Laid out on a straight line from north to south, the equipment making up the line consists of a load table; a motor-driven chain conveyor which transfers bars from the load table to a roller type in-feed conveyor line which is located just west of the load table; four electric heating coils; a ring type spray quenching facility complete with guide rollers for holding the product to be heated and quenched; and a roller type discharge table onto which are attached cradles from which the finished bars are picked up and transferred to the finishing and testing equipment by an E.O.T. crane.
Installation date: 1962.

J. Finishing and Testing Equipment: Located within the heat treatment plant building are a number of pieces of equipment used for finishing and testing bars. These include gag presses, bar straighteners, hack saws, abrasive cut-off machines, bar turners, centerless grinders, hardness testers, and a 25-ton scale. The following gives the general location and manufacturer (when possible) of the equipment within the building:

1. Gag Presses: There are a total of two hydraulic gag presses in the building. Laid out on a north-south axis, gag press No. 1 is located 59' west of the continuous electric heat treating line's tempering furnaces. Gag press No. 2, also laid out on a north-south axis, is located approximately 45' south of the continuous gas fired heat treating line. Both presses consist of an entry table, a gag press station, and a delivery table. Each gag press is approximately 100' long.
Installation dates: 1943 and 1962.

2. Bar Straighteners: The building contains four two roll bar straighteners manufactured by Medart Inc. Bar straightener No. 1 is located 20' east of gag press No. 1 and is laid out on a north-south axis. Bar straightener No. 2, also laid out on a north-south axis is located 20' east of bar straightener no. 1. Bar straightener no. 3 is located 56' from the western wall of the transfer bay and is laid out on a north-south axis. Bar Straightener no. 4, laid out on a south-north axis, is located 82' from the eastern wall of the production bays in the southern end of the building. Each straightener is approximately 85' long and consists of an entry table, two roll station, and a delivery

table.
Installation date: 1943.

3. Hack Saws: There are a total of four hack saws in the building. Manufactured by Marvel Inc., they are located in the southern end of the building and consist of an entry table, hack saw station, and a delivery table. Each unit is 86'-6" long.
Installation dates: 1943 and 1962.

4. Abrasive Cut-off Machines: There are two abrasive cut-off machines in the building. Both machines are laid out on a north-south axis and are located in the transfer bay. Cut-off machine No. 1 is located 25' from the western wall and approximately 10' from the northern wall of the transfer bay. Cut-off machine No. 2 is parallel to and located 12'-6" east of cut-off machine No.1. Each unit, consisting of a positioning table and a saw station, is approximately 35' long.
Installation date: 1943.

5. Centerless Grinder: Laid out on a north-south axis, the centerless grinder is located 78' from the eastern wall of the production bays and approximately 40' south of the continuous electric furnace heat treating line. It consists of 2 lifting tables which flank the grinding station and is approximately 50' long.
Installation date: 1943.

6. Bar Turners: There are two bar turners in the building. Both are laid out on a north-south axis. Bar Turner No. 1 is parallel to bar straightener No. 4, and is located 18' west of it. Bar turner No. 2 is parallel to, and is located 9' west, of bar turner No.1. Each unit is approximately 85' long.
Installation date: 1943.

7. Brinell Hardness Testers: There are two Brinell hardness testers in the building. Laid out on a north-south axis, Brinell hardness tester No. 1 is located approximately 30' south of car bottom furnaces Nos. 4 and 5. About 35' in length, it consists of an entry table/test station and a hack saw table/saw station which extends parallel to each other. Brinell hardness tester No. 2 is located 10' from the western wall of the production bays and is parallel to the southern end of the continuous gas fired heat treating line. Laid out on a north-south axis, it is 90' in length and consists of an entry table/test station, followed by a hack saw table/saw station.
Installation dates: 1943 and 1962.

8. Howe Scale: The 25-ton Howe scale is located 27' west of gag press No. 1. Laid out on a north-south axis, it is 34' long

and is set into the floor of the building.
Installation date: 1943.

HISTORY

The original heat treating plant was installed as part of the Defense Plant Corporation expansion in 1943. The initial purpose of the facility was to heat-treat steel bars that were to be used in the manufacture of guns, shells, and airplane parts. The plant was expanded in 1962 with the construction of a wing to the western end of the building containing additional heat treating equipment.[1]

Heat treatment of steel consists of an operation or combination of operations involving the heating and cooling of the solid material for the purpose of obtaining desired physical properties. In heat treating processes, the steel is subjected to a time-temperature cycle involving two operations -- heating to or above the metal's critical temperature and cooling it to below its critical temperature. The time involved in the heating process and the time it takes to cool the steel after it reached top temperature are crucial determinants in the process of transforming its physical properties.

The critical temperature is the temperature at which the crystalline structure of the metal is altered. Heating steel to above its critical temperature brings it to its so called austenite or transformation stage, while cooling the metal below its critical temperature, depending on the method used in cooling, allows for its physical properties to be permanently altered in a specific manner. There are three major heat treating processes--annealing, normalizing, and quench and tempering. The first two are used to soften steel or make it more ductile. The last is used to harden and increase the toughness of steel.

Annealing is a term used to mean any number of treatments which relieve stresses, and lead to the softening of steel. These treatments may be divided into two general classes--full annealing and sub-critical annealing. Full annealing consists of heating the steel bar above its critical temperature, holding this temperature for one hour per inch of cross-section, followed by slow cooling within the furnace through the critical range until transformation is complete, then ending with air cooling. In general, the slower the rate of cooling the higher the temperature at which transformation occurs and the softer the product. Sub-critical annealing consists of heating the steel just under the critical temperature, holding at this temperature for a specified period of time and air cooling. This method of annealing makes the steel more adaptable to machining and cold shearing, because less scaling or warping results due to the lower temperature reached in heating.

Normalizing consists of heating the steel to 100° above its critical range, holding at this temperature, and cooling in still air at ordinary temperatures. Commercially, normalizing produces a uniform physical structure by removing the irregularities produced by the excessively high or low rolling or forging temperatures.

Quenching and tempering consists of heating steel to a point above its critical temperature and cooling it rapidly by quenching it in a cooling medium such as water, oil, or brine. Because this operation produces an extreme hardness or brittleness in the steel it must be followed by tempering. Tempering consists of re-heating the steel to a point below its critical temperature for the purpose of regulating its hardness or brittleness, toughening it, or releasing stresses. These two operations (i.e. quenching and tempering) are designed to increase the hardness and the toughness of steel beyond that which can be achieved by other heat treatment methods.

Constructed by the American Bridge Company with funds from the Defense Plant Corporation, the original heat treatment plant at the Duquesne Works was housed within a T-shaped building consisting of a transfer bay which was laid out on an east-west axis, forming the cross-member of the T, and a production bay, running in a north-south direction. The major pieces of equipment making up the original heat treatment plant consisted of Car Bottom Furnaces Nos. 1 - 5, and the Continuous Electric Heat Treating Line.

The car bottom furnaces were used in all three major heat treating processes. In the quench and temper process, two car bottom furnaces had to be used in tandem. After the bars had been heated to the proper point above the critical temperature and held for the requisite time, they were quenched in a quench tank located in the transfer bay and immediately put into a tempering furnace which had already been brought up to the proper temperature. The bars would remain in the furnace for the requisite amount of time.

Continuous electric heat treating was done in specific periods of time. Steel bars remained in the different furnaces for the same length of time. The charge was moved into the first or pre-heat furnace and held at 1200°F for a period of from twenty to ninety minutes, depending upon the size of the bar. At the conclusion of the period the charge was moved to the intermediate furnace, set at 1350°F, and another charge was loaded into the first furnace. After intermediate heating, the first charge was transferred into the high temperature furnace where it was heated to a point above its critical temperature and held for a specified period of time before being automatically delivered to the quench tank. After quenching, the bars were transferred to the strain relief furnace where stresses, associated with the quenching, were removed. From the strain relief furnace, the bars were either bypassed out of the furnace system to other locations in the building or transferred to the three furnace stages which made up the tempering process. In this manner, steel continually passes through the furnace line. Upon completion of tempering and ambient air cooling, the steel bars were transferred from the final discharge table to other locations in the heat treating building for testing, straightening, centerless grinding, sawing, or other processing.[2]

The expansion of the heat treating facilities in 1962 involved the addition of car bottom furnace No. 6, the gas-fired continuous heat treating line, and the Ajax mangnethermic induction line. The gas-fired heat treating line operated on the same principle as the electric heat treating line but with fewer furnaces. Bars were charged into the heating furnace and pre-heated before being transferred to the holding furnace where they were held at temperatures up to 1800°F for two hours and then quenched. After quenching they were transferred to the draw furnace where tempering took place at temperatures between 1000°F and 1350°F for up to two hours. The last furnace in line--the draw-holding furnace--was used as a spare in the system. Like the continuous electric heat treating line, the bars were cooled after tempering in ambient air and then transferred to one of several finishing processes. The Ajax magnethermic induction line utilizes electro-magnetic fields to harden and temper steel bars.[3]

<u>ENDNOTES</u>:

1.Defense Plant Corporation, Plancor 186D, "Alloy Steel Plant: Duquesne, Penna." (Washington, D.C., 1943); United States Steel Corporation, "General Arrangement Heat Treating Equipment, West Heat Treating Department: Drawing #47298-A,B,& C."

2.W. A. Jayme, "Heat Treating Plant Design," in Carnegie-Illinois Steel Corporation, <u>Steel Plant Design: Rolling Mills</u>, Vol. III (Pittsburgh: 1950): 1-53.

3. Salem Brosius, Inc., <u>Operations Manual for Gas Fired Continuous Heat Treating Line</u>, (Carnegie: 1962), 1-16; United

States Steel Corporation, "Duquesne Works--Merchant Mill Department: Heat Treat Induction Line," (Pittsburgh: 1971), 5.

STEELMAKING PLANT - BASIC OXYGEN

Historic Name: U.S.S. Corporation, Duquesne Works, Basic Oxygen Steelmaking System
Present Name: U.S.X. Corporation, National-Duquesne Works, Basic Oxygen Steelmaking System
Location: Upper Works
Construction: 1964, 1979, 1982
Documentation: Photographs of the Basic Oxygen Steelmaking Plant are in HAER No. PA-115-B.

DESCRIPTION

I. Flux Handling Building, Trestle, and Covered Conveyor: Located approximately 500'-0" south and 200'-0" east of the BOP shop is the one story, 14'-6" wide x 240'-0" long flux handling building. Laid out on a north-south axis, the steel framed building with corrugated metal exterior was constructed by the American Bridge Company. Its gable roof is supported by structural I-beams. The interior of the building contains a 7 1/2-ton hoist which is attached to a car shaker.

The building sits upon an elevated standard gauge single track trestle which extends 100'-0" past its south wall opening and 220'-0" in front of its north wall opening. Nineteen hoppers are hung from that portion of the trestle which is located under the roof of the building. Located below the hoppers is a 24" motor powered conveyor belt which travels in a northerly direction. The conveyor rises at a 30 degree angle after it passes the trestle and travels through a 8'-0" diameter conveyor tube to the south wall of the BOP shop where it turns at a 90 degree angle and travels in a easterly direction up the wall at a 15 degree angle before turning into the building. Once inside the building, the conveyor, traveling in a northerly direction, rises at a 15 degree angle to the furnace aisle's flux storage floor.

Construction date: 1963.

II. Mould Preparation Building: Built on a concrete foundation by the American Bridge Company, the mould preparation building is located 30'-0" south of the south wall of the BOP shop at its near western teeming aisle. Laid out on a north-south axis, the 170'-8" wide x 480'-0" long x 50'-5" high steel framed, corrugated metal clad structure originally made up the southern end of the furnace building and the mixer building for Open Hearth Number One. The southern end of the existing building (old mixer building) is 117'-3" wide x 58'-0" long. The eastern wall of the old mixer building is coextensive with the centerline of the hot topping platform located inside of the building. The building's monitor roof is supported by Fink trusses.

Running through the center of the building's interior, for nearly its entire length, is an approximately 12'-0" wide x 10'-0" high hot topping platform. The platform is serviced on either side by a 25-ton E.O.T. crane.
Construction date: 1907.

III. Hot Metal Shed: The hot metal shed is made up of a one story, approximately 10'-0" wide steel framed, corrugated metal lean-to attached to the eastern wall of the BOP shop. Laid out on a north-south axis, a standard gauge hot metal track extends through the length of the building. A car puller system is located between the hot metal rails. The car puller moved "submarine" ladle cars into the shed so that the molten iron could be re-ladled at one of the hot metal transfer pits.
Construction date: 1963.

IV. Basic Oxygen Process Building (BOP Shop): Built by the American Bridge Company, the BOP shop is located near the shoreline of the Monongahela River at the northern end of the upper works. Laid out on a north-south axis, the steel framed, six story building is 265'-0" wide x 725'-0" long. It is built on a concrete foundation and has a corrugated metal exterior. The building's gable roof and butterfly monitor is supported by two different types of trusses. The gable on the western side is supported by an arrangement of equally spaced steel I-beams extending downwards from the underside of the roof which are welded to Warren trusses. The gable on the eastern side is supported by Pratt trusses made of welded construction. The BOP shop is divided into four aisles--the charging aisle, the furnace aisle, and two teeming aisles.

A. Charging Aisle: The 90'-0" wide x 725'-0" long charging aisle makes up the ground floor of the far eastern bay of the building. The charging facilities are serviced by two 300/75/25-ton E.O.T. cranes.

1. Hot Metal Transfer Pits: Located near the middle of the aisle along the eastern wall, adjacent to the hot metal track are two 18'-8" wide x 49'-2 1/4" long x 21'-0" deep re-ladling pits spaced approximately 70'-0" apart. Each pit has a fume hood leading up through the eastern wall of the building to where a bag house used to be. A small control room is adjacent to each pit on its northern side.

2. Scrap Transfer and Weighing Facilities: Three standard gauge tracks used for bringing in scrap-filled gondola cars,

extend through an entrance at the southern wall of the aisle. Three scrap boxes, each with a 1500 cu. ft. capacity, and a 100-ton Ametron platform scale upon which the scrap box sits while it is being filled are located along the western side of the aisle near its southern end.

3. Charging Ladles and Cinder Pots: Sitting on the floor at the northern end of the charging aisle are four 175-ton charging ladles and seven 22-ton cinder pots.

B. Furnace Aisle: The 45'-0" wide x 525'-0" long furnace aisle makes up the near eastern bay of the building. It is six stories high. A steel framed stairwell is located at the northern end of the aisle.

1. Ground Floor:

a. Hot Metal and Slag Transfer Cars: One hot metal and one slag transfer car are located on a wide gauge track which extends from the near western teeming aisle to the charging aisle directly underneath each basic oxygen furnace (numbers one and two). Each hot metal transfer car moves to a point underneath its respective furnace from the teeming aisle, while each slag transfer car travels to a point underneath its respective furnace from the charging aisle.

b. Motor Control Centers: Located just north of the wide gauge hot metal and slag transfer tracks at each furnace is a one story, 25'-0" square, steel framed concrete block building. Each building contains a motor-generator set and several switch boxes controlling the motors associated with each furnace.

2. Operating Floor: The operating floor is a 86'-0" wide x 450'-0" long steel framed platform located 32'-6" above the ground floor and 75'-0" south of the northern wall of the charging aisle. Centered on the centerline of the furnace aisle, the platform extends out into the charging aisle on its eastern side and into the teeming aisle on its western side.

a. Basic Oxygen Furnaces: Located along the longitudinal centerline of the furnace aisle are two 170-ton furnaces manufactured by Pecor. Furnace number two is located 50'-0" south of the northern edge of the operating floor; furnace number one is located 100'-0" south of furnace number one. Each furnace is connected by a trunnion to a motor/drive assembly located just north of it.

b. Main Control Buildings: A one story, 20'-8" square concrete block building is adjacent to each furnace on its southern side. The building houses the main controls for furnace operation.

c. Fume Hoods: A 13'-8" diameter, water cooled, fume hood comprised of a membrane-type construction is located directly above each furnace. Each hood doglegs upwards to a quencher on the top floor of the building.

d. Scrap Charging Track: A wide gauge track runs along the floor on the charging or eastern side of the furnace. The track carried a scrap charging transfer car before scrap charging was accomplished with overhead cranes.

e. Ladle Additive Bins: Four 400 cu. ft. capacity ladle additive bins laid out linearly on a north-south axis are suspended from the service floor just south of furnace number two on its tapping or western side. Two of the bins contained ferromanganese, and two contained ferrosilicon.

f. Ladle Additive Chutes: A steel framed chute hangs from the floor on the northern and southern side of each furnace at a 45 degree angle. The chutes direct ferromanganese or ferrosilicon into the teeming ladle after the furnace has been tapped.

g. Elevator Shaft: One 12'-2" wide x 16'-9" long elevator shaft leading from the ground floor to the roof of the building is located 13'-7" south of furnace number one's main control building on its tapping side.

h. Main Office and Chemical Laboratory Building: Located 14'-3" due south of the elevator shaft is a one story, 35'-4" wide x 212'-0" long concrete block building. The building houses the BOP shop's main offices, its chemical laboratory, and locker rooms.

3. Service Floor: The 86'-0" wide x 225'-0" long service floor is composed of a steel framed platform 32'-3" above the operating floor. The northern edge of the floor coincides with the northern edge of the operating floor.

a. Batching Hoppers: One 11'-9 1/2" top I.D. x 3'-6 5/8" bottom I.D. x 16'-2" high cone shaped batching hopper is suspended from the batching floor just south of the fume hood for each furnace. A gate operated, water cooled flux chute leads from the bottom of each batching hopper at a 40 degree angle through the fume hood into the top opening of each furnace.

b. Oxygen Lances: Two oxygen lances per furnace are hung from a lance positioning and hoisting rig assembly extending upwards to the flux storage floor of the building. The lances enter the top opening of each furnace through a collar protected opening on each fume hood.

4. Batching Floor: The 86'-0" wide x 225'-0" long batching floor is located on a steel framed platform 20'-3" directly above the service floor.

a. Weigh Hoppers: Located in the middle of the floor and laid out linearly on a north-south axis are six weigh hoppers hanging from the weighing floor. They are composed of two 100 cu. ft. capacity spar hoppers, two 100 cu. ft. capacity ore hoppers, and two 600 cu. ft. capacity lime hoppers. Attached to the bottom of each hopper is a Carrier feeder conveyor.

b. Scales: Six Rex scales are located directly opposite their respective weigh hoppers on the western side of the floor.

c. Main Flux Conveyor Belt: A 30" wide x 95'-0" long, 268 ton per hour reversible conveyor belt powered by a 7.5 hp motor is located directly below the feeder conveyors attached to the bottom of each weigh hopper. Laid out on a north-south axis, the main conveyor belt delivers the raw material batches to one of two cross conveyors.

d. Cross Conveyor Belt: A 30" wide x 15'-0" long conveyor belt, running in a easterly direction, is located at the north end of the main conveyor belt. The conveyor is powered by a 5 hp motor. The raw material batches drop onto the cross conveyors from the main belt and are delivered to the top opening of the batching hoppers.

5. Weighing Floor: Located 14'-6" directly above the batching floor, the 86'-0" wide x 225'-0" long weighing floor is made up of a steel framed platform.

a. Storage bins: Laid out on a north-south axis, seven storage bins are suspended from the flux storage floor. Two 2750 cu. ft. capacity lime bins, two 1890 cu. ft. capacity spar bins, and two 1800 cu. ft. capacity ore bins are located directly above their respective weigh hoppers on the floor below. A 1750 cu. ft. capacity coke storage bin is located at the southern end of the line. Each of the lime, spar, and ore bins has a Carrier feeder conveyor attached to its bottom opening. The conveyors drop their contents into a chute which leads to the top openings of the weigh hoppers below.

b. Oxygen Lance, Fume Hood and Stack Cooling Water

Pumps: Located on the western end of the floor are the motor/pump assemblies for oxygen lance, fume hood, and stack cooling. The cooling water facilities for furnace number one are laid out linearly on a north-south axis just south of the storage bins. They consist of two 60 hp Allis-Chalmers motors, each driving a 450 gpm Wilson-Snyder pump for lance cooling, and three 250 hp Allis-Chalmers motors, each driving a 2700 gpm Wilson-Snyder pump for fume hood and stack cooling. The cooling water facilities for furnace number two are laid out linearly on a north-south axis just north of the storage bins and consist of the same equipment described for furnace number one.

c. Motor/Winch Drum Assemblies for Oxygen Lance Hoisting Rigs: Located opposite each of the cooling water facilities described above along the eastern end of the floor are the motor/winch drum arrangements for the lance hoisting rigs at each furnace. Each arrangement consists of two 19 hp Westinghouse D.C. motors connected to a gear drive and a winch drum.

6. Flux Storage Floor: The 86'-0" wide x 225'-0" long flux storage floor is located on a steel framed platform 30'-6" directly above the weighing floor.

a. Flux Conveyor Belt: A 24" wide, 200 ton per hour conveyor belt, manufactured by the Chain Belt Company, runs along the center of the floor for nearly its entire length. The conveyor belt is powered by a 20 hp motor. The belt is an extension of the covered conveyor leading from the flux handling building to the BOP shop.

b. Tripper: Running on rails which straddle the raw material conveyor belt is a tripper manufactured by the Chain Belt Company. The tripper's chutes divert the material traveling along the conveyor through openings in the floor to its respective storage bin.

c. Lance Hoisting Rigs: Two steel framed lance hoisting rigs per furnace are located along the eastern end of the floor above the lance opening in the fume hoods for each furnace.

d. Quenchers: See description VI - A below.

C. Near Western Teeming Aisle: The near western teeming aisle is 64'-5" wide x 525'-0" long. It is located on the ground floor of the building's near western bay and is serviced by two 300/75/25-ton E.O.T. cranes.

1. Teeming Platform: An approximately 8'-0" wide x 200'-0" long x 10'-0" high steel framed teeming platform is located along the western side of the aisle near its southern end. Running on the floor alongside the platform through the entire length of the aisle is a combination narrow and standard gauge track.

2. Ladle Repair Pit: Laid out on a north-south axis along the eastern side of the aisle near its northern end is a 21'-4" wide x 37'-10" long x 18'-4" deep concrete ladle repair pit. The pit is capable of servicing two ladles at a time.

D. Far Western Teeming Aisle: The 65'-7" wide x 525'-0" long far western teeming aisle makes up the ground floor of the building's far western bay. The bay is serviced by two 300/75/25-ton E.O.T. cranes.

1. Teeming Platform: An approximately 8'-0" wide x 10'-0" long steel framed teeming platform extends the length of the aisle along its western wall. A combination narrow and standard gauge track set upon the floor alongside the platform runs its entire length.

2. Teeming Ladles: Four 175-ton teeming ladles are located on the eastern side of the aisle near its northern end.
Construction date of BOP shop: 1963.
Construction of 200'-0" extension to northern end of charging aisle: 1976.
Installation of all equipment within building: 1963.

V. Clean Steel Production Building: Laid out on a north-south axis, the clean steel production building is an extension to the northern end of the BOP shop's near western teeming aisle. Constructed by the American Bridge Company, it is a 64'-5" wide x 200'-0" long x 80'-0" high steel framed, corrugated metal clad building, built on a concrete foundation. The building's gable roof is supported by Fink trusses.

Located inside of the building is an approximately 8'-0" wide x 10'-0" high steel framed platform running along the western wall of the building for its entire length. A combination narrow and standard gauge track set upon the floor extends from the BOP shop's near western teeming aisle along the entire length of the platform. Argon gas was blown into recently teemed ingot moulds from the platform for the purpose of removing entrained gases from the steel.
Construction date: 1982.

VI. Gas Cleaning Facilities:

A. Quenchers: One 11'-5" wide x 18'-3" long x 10'-6" deep pyramidal shaped spray water quencher is located 25'-0" north of each furnace on the BOP shop's furnace aisle flux storage floor.
Installation date: 1963.

B. Rough Gas Mains: One 12'-0" diameter rough gas main extends from the bottom opening of each quencher. Each rough gas main runs in a northerly direction from its respective quencher before tying together into one 12'-0" diameter pipe which passes through the north wall of the building at an elevation of approximately 110'-0" above grade. The pipe continues to travel in a northerly direction for a distance of 340'-0" before it enters a tee on the roof of the gas quencher pump house. From the tee, the gas is directed downwards into the top of the dual Venturi washers located inside the pump house.
Installation date: 1963.

C. Gas Quencher Pump House: Laid out on a east-west axis, the gas quencher pump house is located 340'-0" north of the BOP shop. The 28'-0" wide x 60'-0" long, five story, steel framed building is divided into three bays. It has a corrugated metal exterior and a flat roof.
Construction date: 1963.
Construction of 20'-3" extension to eastern end: 1976.

1. Gas Quench Pumps: Two Wilson-Snyder 900 gpm gas quench pumps, each powered by a 200 hp motor, are located in the western bay on the ground floor of the pump house.
Installation date: 1963

2. Slag Slurry Transfer Pump: See IX - B below.

3. Standpipe: See IX - A below.

4. Gas Cleaning Plant Office: The office is located on the ground floor in the building's eastern bay. A schematic panel board showing the steps in the gas cleaning and water treatment processes is located along its southern wall.
Construction date: 1963.

5. Dual Venturi Scrubbers: One set of 276,760 cfm capacity dual venturi scrubbers, manufactured by the American Air Filter Company, is located in the eastern and western bay of the building on its fourth floor. The brick-lined gas scrubbers are designed to receive rough gas at temperatures up to 185 degrees F.
Installation of dual venturi scrubber in western bay: 1963.

Installation of dual venturi scrubber in eastern bay: 1976.

D. Gas Cooling Towers: One tile-lined gas cooling tower, manufactured by the American Air Filter Company, is located just north of each dual venturi scrubber. Each tower is connected to its respective dual venturi scrubber by a flooded elbow. The tower associated with the scrubber in the western bay of the gas quencher pump house is 29'-0" diameter x 103'-3" high. It is designed to receive gas at 386,000 cfm and to cool the gas down to 110 degrees F. The tower associated with the scrubber at the eastern bay has a diameter of 22'-0" and is 84'-6" high. It is designed to receive gas at 146,000 cfm and to cool the gas down to 110 degrees F.

Installation of gas cooling tower north of western bay: 1963.
Installation of tower north of eastern bay: 1976.

E. Gas Washer Pump House: Laid out on an east-west axis, the gas washer pump house is located just north of the gas quencher pump house. The 28'-0" wide x 60'-0" long, one story steel framed building is divided into two equal bays. Each bay is built around the bottom cone of the gas cooling towers. The steel framed building has a corrugated metal exterior.

Located in the western bay of the pump house are three 125 hp motor-powered Wilson-Snyder cooling tower water pumps rated at 5500 gpm, and two 150 hp motor powered Allis-Chalmers venturi recycle pumps rated at 3300 gpm.

The eastern bay of the pump house contains two 125 hp motor-powered Wilson-Snyder cooling tower water pumps rated at 5500 gpm, and one 150 hp motor-powered Allis-Chalmers venturi recycle pumps rated at 3300 gpm.

Construction of original pump house: 1963.
Construction of 30'-0" extension to eastern end: 1976.
Installation of equipment in western bay: 1963.
Installation of equipment in eastern bay: 1976.

F. Fans and Stacks: Connected to the outlet pipe of each gas cooling tower is an American Air Filter Company manufactured, motor-powered fan and stack. The fans blow the clean gas travelling through the downcomer outlet pipes of the gas cooling towers up through the stacks and into the atmosphere. The stack associated with each gas cooling tower has a 9'-0" diameter and is 151'-0" high.

Installation of fan and stack associated with the western gas cooling tower: 1963.
Installation of fan and stack associated with the eastern tower: 1976.

VII. Water Treatment Facilities:

A. Scupper: The scupper is connected to the underside of the rough gas main just before the main enters the tee on the roof of the gas quencher pump house. It separates out the dirty gas quencher water from the rough gas main and directs it to a 12" diameter pipe which carries it downward at a rate of 1050 gpm to one of two rake classifiers.
Installation date: 1966.

B. Rake Classifiers: Two Dorr-Oliver rake classifiers with a capacity of 40 tons a day are laid out on a east-west axis between the western wall of the gas quencher pump house and the eastern wall of the filter cake house. The hydraulically-powered shallow drag-out classifiers sweep settled solids up an inclined rake to a dewatering hopper.
Installation date: 1966.

C. Cooling Tower Slurry Pumps: Located in the western bay of the gas washer pump house are two 7 1/2 hp motor-powered Allis-Chalmers slurry pumps rated at 500 gpm. A 10 hp motor-powered Allis-Chalmers slurry pump rated at 600 gpm is located in the eastern bay of the gas washer pump house.
Installation of pumps in western bay: 1963.
Installation of pump in eastern bay: 1976.

D. Clarifier and Sludge Pumps: Located just north of the fans and stacks for the gas cooling towers is one 85'-0" diameter x 9'-6" high clarifier complete with a 3 hp motor-powered sludge rake and a 15'-0" diameter centerwell. A 2'-6" wide x 3'-0" deep launderer encircles the circumference of the clarifier.

Two 10 hp motor-powered Gallagher sludge pumps rated at 90 gpm are located in a tunnel beneath the clarifier. The pumps deliver sludge to the filter cake house.
Installation date: 1963.

E. Filter Cake House and Sludge Dewatering Equipment: Laid out on a north-south axis, the one story, 36'-0" wide x 40'-0" long filter cake house is located approximately 30'-0" west of the gas quencher pump house. Built on a concrete foundation by the American Bridge Company, the steel framed building sits on top of a 21'-6" high raised steel framed platform. It has a corrugated metal exterior and its gable roof is supported by structural channels.

Two 75 hp motor-powered Nash-Hytor vacuum pumps with vacuum silencers are located near the south wall of the building. Each pump is connected by means of a 12" diameter pipe to a drum filter assembly. Laid out on a north-south axis, each Dorr-Oliver vacuum drum filter assembly consists of a 10'-0" diameter x 18'-0" long cloth covered drum set inside a basin. The eastern side of each basin consists of a slurry tub, the western side consists of a chute leading directly to a dumping area below. Located just south of each drum filter, near the eastern and western walls of the building is a 2'-0" diameter x 10'-0" high filtrate receiver. Also associated with each vacuum drum assembly is a set of compressed air piping.

Construction date: 1963.

Installation of all equipment: 1963.

F. Acid Storage Tank: A 10,000 gallon capacity sulfuric acid storage tank is located along the northwest side of the clarifier. The 20'-0" diameter x 19'-0" long tank sits in a limestone filled pit.

Installation date: 1979.

G. Neutralization Tank: A 6,175 gallon capacity neutralization tank is located along the western side of the clarifier. Overflow water from the clarifier's launderer is treated with sulfuric acid in the 9'-1" diameter x 13'-0" high tank before 900 gpm of the water is recycled by gravity to the gas quench pumps while the remainder (750 to 1800 gpm) is fed to the wet well.

Installation date: 1979.

H. Wet Well: Located just west of the neutralization tank and laid out on a north-south axis is a 10'0" wide x 17'-0" long x 15'-0" deep, 18,000 gallon capacity concrete wet well. The well partially extends into the southwest corner of the chemical feed pump house. Water entering the wet well is treated with a calcium dispersant before it is pumped over to the filtration system.

Construction date: 1979.

I. Chemical Feed Pump House: Laid out on a north-south axis, the 14'-0" wide x 22'-8" long x 10'-8" high pump house is located just north of the neutralization tank. Built on a concrete foundation, the building is constructed of concrete block.

Three vertical cantilevered, variable speed Morris pumps (450 or 900 gpm) powered by 30 hp motors, are laid out linearly in the southwestern corner. They pump water from the wet well to the filtration system. Four 1/2 hp Milroyal A metering pumps are laid out linearly along the northern wall. The two western pumps deliver sulfuric acid at a rate of 1.1 gpm to the neutralization tank. The eastern pumps deliver calcium dispersant to the wet

well at a rate of .4 gph.
Construction date: 1979.
Installation of equipment: 1979.

J. Calcium Dispersant Tank: The 6'-0" diameter x 10'-0" high, 2000 gallon capacity, calcium dispersant tank is located between the acid storage tank and the chemical feed pump house.
Installation date: 1979.

K. Gravity Filter Building: Laid out on a east-west axis, the 40'-0" wide x 63'-0" long x 30'-0" high steel framed water filtration building is located 4'-0" south of the filter cake building. Built by the American Bridge Company on a concrete foundation, the building has a corrugated metal exterior and a flat roof. The southern corner of the building has been removed for road clearance.

A 7'-3/4" wide x 34'-10 1/2" long x 21'-6" high DeLaval gravity filter is laid out on a east-west axis alongside the northern wall of the building. Constructed of steel plate, the filter is made up of four identical cells which are designed to remove suspended solids from raw water while maintaining a high flow rate through a filter. The filter consists of a top layer of anthracite coal and a bottom layer of sand, supported by several layers of graded gravel.

A polymer feeding system for the gravity filter is located just west of it alongside the northern wall. It consists of two 55 gallon polymer storage tanks which are connected to two 1/2 hp Milroyal A metering pumps.

A 12'-6" diameter x 21'-6" high Delaval backwash holding tank is located south of the gravity filter near the southern wall of the building. A 7 1/2 hp motor-powered "Lightnin" mixer extends down through the center of the tank. Two 7 1/2 hp motor-powered Morris pumps rated at 180 gpm are located on the southern side of the tank. The pumps deliver slurry from the holding tank to the clarifier.

Located just east of the gravity filter and backwash tank, and laid out on a north-south axis is a 11'-0" wide x 25'-0 long x 15'-0" deep concrete sump covered by grating. The sump is divided by a V-shaped weir into two sections. Extending from the northern section of the sump are two 30 hp motor powered Morris vertical cantilevered sump pumps rated at 1050 gpm. These pumps deliver backwash water to the gravity filters. Located above the southern section of the sump is a polymer feed system for the clarifier. The system consists of a small mixing tank, a feed tank, and a small (approximately 100 gpm) motor-powered pump.

Two Delaval 30 hp motor-powered air blowers are located east of the clarifier polymer feed system near the eastern wall of the building. A motor control center, complete with a 2'-0" wide x 6'-0" long x 6'-0" high control panel is located north of the air blowers.

Construction date: 1979.

Installation of equipment: 1979.

VIII. Cinder Yard: Originally part of Open Hearth Number One, the cinder yard is laid out on a north-south axis due north of the BOP shop's charging aisle. It is 73'-0" wide x 170'-0" long and is serviced by a 25-ton E.O.T. crane located on a 45'-0" high craneway.

Construction date: 1900.

IX. Remains of Slag Granulating and Separation Facilities:

A. Standpipe: A 12'-0" diameter x 30'-6" high standpipe is located in the middle bay of the gas quencher pump house. The standpipe receives a slag slurry from the slag granulating tanks which have since been removed from the cinder yard.

Installation date: 1965.

B. Slag Slurry Transfer Pump: A 25 hp motor-powered Morris slurry transfer pump rated at 650 gpm is located just west of the standpipe on the ground floor of the gas quencher pump house's western bay. The pump transferred the slag slurry from the standpipe to the magnetic separator in the slag separation building.

Installation date: 1965.

C. Slag Separation Building: Laid out on a north-south axis and built by the American Bridge Company, the three story, 19'-0" wide x 28'-0" long slag separation building is located just south of the gas quencher pump house. It sits on top of a raised steel platform 40'-4" above grade. The steel framed building has a corrugated metal exterior, and a gable roof supported by I-beams.

A magnetic separator consisting of a 8'-6" wide x 12'-6" long x 6'-8" high basin in which three 2'-6" diameter magnetic rotating drums are placed side by side is located in the northwest corner of the building's third floor. The separator receives a slag slurry through the top of the basin and the rotating drums separate out the steel tailings from the slag.

Two chutes extending from the bottom of the magnetic separator lead to two horizontal filters which are located on the second floor of the building. The larger filter (11'-6" diameter x 4'-0" high) receives the slag slurry. It is located at the northern end of the floor. The smaller filter (6'-10" diameter x 3'-3" high) receives the iron tailings slurry and is located in the southwest corner of the floor. The filters separate the filtrate from the steel and slag.

Chutes extending from the bottom of the each filter project down through the first floor of the building to two large bins (one for slag concentrates and one for steel tailings) which are hung from the raised platform. Other extant equipment on the first floor of the building includes a 1'-6" diameter x 4'-3" high filtrate receiver which receives the filtrate from the horizontal filters and a vacuum pump which keeps the filtrate receiver under a vacuum.
Construction date: 1965.
Installation of all equipment: 1965.

X. Skull Cracker Enclosure: The steel framed, 74'-6" wide x 231'-0" long x 66'-9" high enclosure is covered with wire mesh and located due north of the cinder yard. Built from a concrete foundation, it was originally part of the Open Hearth Number One complex. Located inside of the enclosure is a 51'-6" high craneway which runs its entire length. Two 25/10-ton E.O.T. cranes are located on top of the craneway.
Construction date: 1900.

XI. Electrical Sub-Station Building: Located near the northern end of the BOP shop, between the clean steel production building and the 200'-0" extension to the BOP shop's charging aisle is the two story, 34'-0" wide x 77'-0" long indoor electrical sub-station building. Constructed of brick on a concrete foundation, the building's two floors house control panels for all of the BOP's electrical facilities.
Construction date: 1963.

HISTORY

Built on the grounds formerly occupied by Open Hearth Number One, the basic oxygen steelmaking process was begun at the Duquesne Works in December of 1963. It marked the first use of that process by a facility owned by the United States Steel Corporation. With the shutdown of Open Hearth Number Two in 1965 the basic oxygen process completely supplanted open hearth steelmaking at Duquesne because of its ability to produce a wide range of special high grade alloy, silicon, and carbon steels traditionally made on the site. Capable of producing eighty different grades of steel at start-up, the new facility was one of the nation's earliest to utilize the basic oxygen process for such purposes. In addition, it was the first of its kind to produce large tonnages for electrical sheet steel and construction carbon and alloy steels.

The process essentially involved blowing 1500 cfm of gaseous oxygen under a pressure of 150 psi down through a lance set just above a proportioned charge of scrap steel (up to 30% of the charge), molten iron, and fluxing materials contained within a barrel shaped, basic (magnesite brick) lined, concentric furnace with an open top. The exothermic reaction between the oxygen and the metallic bath converted the iron into steel by eliminating carbon, silicon, manganese, sulphur, and phosphorus through oxidation. An average blow lasted approximately twenty-two minutes.[1]

As evidenced by Duquesne's quick conversion to exclusive use of the process and by the short period required to make a heat, basic oxygen combined the versatility of the open hearth process with the speed of the Bessemer steelmaking process. This was due to three factors. First, the successful adaptation of the Linde/Frankel process, which separated oxygen from air, enabled steelmakers to develop a pneumatic system capable of producing much larger tonnages of steel per heat, in approximately the same amount of time than was possible under Bessemer production. Because of the relatively shorter heat times, moreover, the basic oxygen process produced tonnages comparable to the open hearth process while employing significantly fewer furnaces. Second, the use of a basic lining in the furnace made it possible to eliminate phosphorus from the charge of molten iron because it allowed for the addition of basic fluxing materials during the process. Finally, increased knowledge about the correct proportions of materials to be charged into the furnace relative to the metallurgical requirements of the steel to be made in the heat combined with improved instrumentation for temperature measurement to create a situation where a great variety of steels could be made while maintaining temperature control.

Laid out on a north-south axis, Duquesne's basic oxygen steelmaking plant was located at an equal distance between the blast furnace plant and primary rolling mills. All charging materials flowed to the oxygen furnaces from a southerly direction. When the plant first went into operation, the process began by charging the furnace with scrap steel, followed by molten iron. Fluxing materials were added shortly after the heat had begun. The composition, exact weight, and temperature of the raw materials were determined by a computer located in the production planning office according to the specifications of the steel to be made in the heat.

A twenty-four hour supply of scrap, stored in gondola rail cars, was located in the scrap yard at the southern end of the

BOP shop's charging aisle. The scrap was loaded from the rail cars directly into a scrap box (ranging from 1000 cu. ft. to 1500 cu. ft capacity) set upon a floor scale, by a magnet attached to a E.O.T. crane. After weighing, the box was transported by the crane to the furnace aisle's operating floor where it was placed onto a scrap charging machine, traveling over a wide gauge track in front of the furnaces. The machine hydraulically dumped the contents of the box into the furnace which was rotated on its trunnions to the charging position (at an angle of approximately 45 degrees toward the charging aisle).

Molten iron was delivered from the blast furnace plant to the BOP shop's hot metal shed in "submarine" ladle cars. Each ladle car was positioned next to one of two hot metal transfer pits, where 175-ton charging ladles, resting on transfer cars, were positioned by remote control to receive the charge of molten iron. Before the molten iron was re-ladled, a proportioned amount of calcium carbide was thrown into the bottom of the charging ladle for the purpose of desulphurization. As the molten material was transferred from the "submarine" car to the charging ladle, the resultant fumes were directed up through a fume hood to a bag house located on the eastern side of the BOP shop. With the completion of re-ladling, the charging ladle was picked up by an E.O.T. crane and transported across the charging aisle to a skimming station where the slag, created by the reaction of the molten metal with the calcium carbide, was manually skimmed off the bath. The ladle was then lifted up by the crane to the operating floor of the furnace aisle and charged into the furnace which was rotated to its charging position. At this point, the furnace was rotated to its upright or operating position and the heat was begun by turning on the oxygen after the oxygen lances had been dropped into place. Immediately after the heat had started, fluxing materials were added to the furnace.

Fluxing materials such as iron ore, fluorspar, and burnt lime were periodically delivered from storage bins located at the flux handling facility by means of a covered conveyor leading to the top floor (flux storage floor) of the furnace aisle where they were fed by gravity through a tripper into storage bins located on the floor below (weighing floor). Materials were fed from the storage hoppers by gravity to weigh hoppers on the batching floor and automatically weighed. After weighing, the materials fell onto conveyor belts which dropped them into the batching hopper located on the service floor directly above the furnace. The materials were eventually fed into the furnace through an opening in its fume hood by means of a water cooled chute attached to the bottom opening of the batching hopper.

Operation of the furnace lasted for approximately twenty-two minutes. Near the end of the heat, the furnace was rotated to its charging position and a sample of the bath was taken in order to determine its temperature. This was done because the elimination of the metallurgical elements was keyed directly to the temperature of the bath (i.e. on a rising temperature scale silicon would oxidize first, followed by manganese, phosphorus, carbon, sulphur, and iron). If the temperature was too high, a proportioned amount of scrap was added to the bath in order to replace the elements needed to meet the requirements of the heat. If the temperature was too low, the furnace was returned to its operating position and oxygen was blown down through the bath for a predetermined amount of time.

When the heat was completed, the furnace was rotated to its tapping position (at an angle of 90 degrees toward the near western teeming aisle). A 175-ton teeming ladle, which was placed on a transfer car running in an east-west direction on a wide gauge track from the near west teeming aisle underneath the furnace, received the molten steel. The tap hole from which the molten material flowed was located below the slag-metal interface so as to prevent most of the slag from mixing with the steel as the furnace was being tapped. After the steel was tapped, the transfer car was run out into the teeming aisle and the ladle was picked up by an E.O.T. crane and carried over to a platform where it was teemed into ingot moulds. At the same time, a transfer car, running in an east-west direction on wide gauge tracks from the charging aisle, carried a 22-ton cinder pot underneath the furnace. The furnace was then rotated 270 degrees to an inverted position, thereby allowing the slag to drop directly into the pot. Subsequently, the pot was picked up by an E.O.T. crane and transported to the cinder yard where the slag was dumped.

During its operation, fumes from the furnace flowed upward through a water cooled fume hood to a quencher where they were sprayed. The resulting gas and slurry passed through a 12'-0" diameter rough gas main to the top of the gas quencher pump house where the slurry was directed to the wastewater treatment system, while the gas flowed downward, at a rate of 325,000 cfm, to a dual venturi gas scrubber. The scrubber was linked to a gas cooling tower. Together they operated in much the same way as each of the venturi scrubber/gas cooling tower arrangements installed at blast furnaces numbers three and four in 1971. After the cleaned and cooled gas had passed through the gas cooling tower, it was vented into the atmosphere through a stack with the aid of a large fan.

Wastewater from the gas cleaning system was treated in two ways. Slurry from the quencher was directed through the scupper and pumped under high pressure into a Dorrclone. Shaped like a cone and set at a slight angle to a horizontal plane, the Dorrclone separated the heavy solids from the quencher slurry by centrifugal force. The solids dropped through the small end of the cone into a chute leading to a sludge dump, while the filtrate exited at the top, or large end of the cone, and flowed by gravity to a 90'-0" diameter clarifier. All slurry from the dual venturi scrubber and gas cooling tower passed by gravity into the clarifier. Clarified water exited into the basin's launderer and was directed to a sewer leading back to the Monongahela River. Sludge was pumped from the clarifier by underflow pumps to the filter cake house where it was dried and deposited into a dumping area by vacuum drum filters. The drum filters operated in the same way as the disc filters in the blast furnace plant.[2]

Shortly after the basic oxygen steelmaking facility went into production, several important changes were made to its by-product (slag handling, gas cleaning, and water treatment) and teeming operations. In 1966, an ill-fated slag granulating and separation facility was constructed on the site. Designed by the company's research center in Monroeville, Pennsylvania, to separate steel tailings or residue from BOP slag, the system included two slag granulating tanks, a 12'-0" diameter stand pipe, and slag separation equipment. The process began by feeding slag from the oxygen furnace into a tundish leading to one of the granulating tanks. The slag was sprayed with water, thereby granulating it, as it entered the tank and was pumped with the water to the standpipe. From the standpipe, which acted as a surge tank, the slurry was pumped to the magnetic separator at the top floor of the slag separation building. The separator's magnetic drums segregated steel tailings from the slag. Both the steel and the slag were subsequently delivered by chute to their respective horizontal filters located on the floor below. The filters separated the filtrate from the solid materials. The slag and steel were then gravity fed through chutes to their respective holding bins while the filtrate was fed into a receiving tank and delivered to the clarifier at the water treatment facility. Periodically, the granulated slag and the steel tailings were removed from the holding bins by truck. The granulated slag was delivered to the United States Steel Corporation's Universal Cement Company, while the steel tailings were charged back into the oxygen furnace with the scrap charge.

Despite best efforts by system operators to make the facility work, the slag granulating and separation complex was shut down after only two years of operation. The process never achieved the required seven percent yield of steel tailings from the by-product mass in order to be profitable.[3]

An important change to the gas cleaning system occurred in 1976 when a second dual venturi washer and gas cooling tower were added, thus greatly increasing the system's capacity. Significant changes to the water treatment facilities took place in 1966 and 1979. In the former year, the Dorrclone was replaced by a grizzly and two reciprocating rake classifiers. Difficulties with the Dorrclone centered on its inability to efficiently separate entrained particulate from the gas quencher wastewater by the centrifugal force method, and by excessive maintenance costs caused by the highly abrasive matter entrained in the fumes emanating from the oxygen furnace. The new equipment solved these problems by handling the quencher wastewater in three stages. During the first stage, quencher wastewater was delivered from the rough gas main through the scupper to the top opening of the grizzly, which was nothing more than a vertical cylinder outfitted with a screen to catch and divert large entrained particulate to a dumping area. After passing through the grizzly's screen, the slurry was next fed to one of the reciprocating rake classifiers. The classifier consisted of an hydraulically powered rake which swept solids that had settled in a shallow, rectangularly shaped basin up an incline into a dewatering hopper while the remaining filtrate was delivered by gravity to the clarifier for further treatment.

Additional water treatment equipment was added in 1979 for the purpose of meeting E.P.A. clean water standards. Designed to partially recycle wastewater from the gas cleaning system, major additions to the water treatment complex included a 6,175 gallon capacity neutralization tank, a 18,000 gallon capacity wet well, a gravity filter, and a variety of chemical feed equipment. The expanded system began with the feeding of polymer additions to the water overflowing into the clarifier's launderer. From the launderer, water at a rate of 900 gpm was delivered to the neutralization tank where it was treated with sulfuric acid in order to prevent scaling in the system's equipment, and to assure that the wastewater remain within an acceptable pH range before being gravity fed to the quencher supply pumps. The remainder of water in the system (from 750 to 1800 gpm) was sent to the wet well and treated with a calcium dispersant to control scaling. Wet well water was subsequently blown back to the river after it passed through a gravity filter.[4]

Finally, in 1982, a clean steel production building was built onto the northern wall of the near west teeming aisle. The building housed a teeming platform and was equipped with argon delivery facilities. Argon was used to provide a shield for the molten steel as it was teemed from the ladle to the ingot moulds. This was done because exposure to the oxygen during the teeming process had a tendency to create defects in the form of inclusions in solidified ingots.[5]

ENDNOTES:

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2.United States Steel Corporation, "Description of Linde-Frankel Process," Unpublished Notebook for Plant Managers, Pittsburgh, 1960, 2101-03; U.S. Steel Corporation, The Making, Shaping, and Treating of Steel, Ninth Edition, 486; "Modernization Program at Duquesne Works Marked by Completion of Two 150-Ton OSM Furnaces," Iron and Steel Engineer 41 (July 1964): 201-04; "OSM Shop Is Important Addition in Duquesne Works Expansion," Blast Furnace and Steel Plant 52 (August 1964): 719-21, 732; United States Steel Corporation, "General Arrangement - Standpipe Slurry Degritting - OSM Plant: Drawing #49569, August 1, 1963."

3.United States Steel Corporation, "Slag Granulating System-Control Diagram: Drawing #51925, September 17, 1965"; U.S. Steel Corporation, "Location Plan and Key Sheet-Slag Granulating Facilities-B.O.F. Plant: Drawing #51922, August 14, 1965."; U.S. Steel Corporation, "Equipment Location-Slag Granulating-Separation Station - B.O.F. Plant: Drawing #51945, December 14, 1965."; Joel Robert Zimmer, former Maintenance Manager at the Duquesne Works, Interview with author, July 27, 1990.

4.United States Steel Corporation, "Additional Gas Cleaning Facility - BOP - General Arrangement - Plan -Duquesne Plant: Drawing #63492, August 15, 1975."; U.S. Steel Corporation, "Additional Gas Cleaning Facility - BOP - General Arrangement - Duquesne Plant: Drawing #63493, August 27, 1975."; U.S. Steel Corporation, "Process Control Diagram - Gas Cleaning Plant - O.S.M.: Drawing # 49265, Revision #7, April 15, 1966."; Wayne Cadman, former General Superintendent of Plant Utilities, Interview with author, August 4, 1989; U. S. Steel Corporation, Operation Manual, Project No. 535-6017, "Additional W. Q. C.

Facilities - BOP Shop - Duquesne Works," (Monroeville: 1979): 1-7.

5.United States Steel Corporation, "U.S. Steel-Mon Valley Works-Duquesne Plant Property Inventory List," (Duquesne: 1984), 13.

STEELSHAPING - ROLLING MILLS

Historic Name: U.S.S. Corporation, Duquesne Works, Primary Rolling Systems
Present Name: U.S.X. Corporation, Duquesne Works, Primary Rolling Systems
Location: Upper and Lower Works
Construction: 1886, 1900, 1959
Documentation: Photographs of the Primary Mills are located in HAER No. PA-115-D.

DESCRIPTION

I. Remains of Primary Rolling Facilities at Upper Works:

A. Forty-Inch Conditioning Yard (Formerly the Forty-Inch Mill Shipping Building): Laid out on a north-south axis, the steel-framed forty-inch conditioning yard is located at the western edge of the upper works, just south of the pattern shop. The 69'-7 1/2" wide x 528'-0" long x 43'-9" high riveted steel-framed building was constructed by the American Bridge Company on a concrete foundation. Its gable roof and monitor are supported by Fink trusses. A craneway spanning the width of the building and running its entire length supports two 15-ton E.O.T. cranes. The building has a corrugated metal exterior.

A standard gauge track, running inside of the building along its western wall enters from an opening on its south wall. Located in the northeast corner of the building is a bloom/billet warming oven used prior to conditioning. Three hacksaws for metallurgical testing are located in the northeast corner of the building. A small office is located inside the building near its northern wall. Laying about the floor space at the southern end of the building are pallets of firebrick.
Construction date: 1924.

B. Twenty-One Inch Conditioning Yard (Formerly the Twenty-One Inch Mill Inspection Building): The 92'-0" wide x 481'-0" long x 45'-0" high twenty-one inch conditioning yard was built by the American Bridge Company. It is laid out on a north-south axis and is located approximately 110'-0" east of the pattern shop and forty-inch conditioning yard near the northern edge of the upper works. The riveted steel-framed building is built on a concrete foundation. Its gable roof and monitor are supported by Pratt trusses. A craneway spanning the width of the building, and extending its entire length supports one 15-ton E.O.T. crane. The building has a corrugated metal exterior. An approximately 20'-0" wide x 15'-0" high doorway is located at mid-point of the building's northern wall. A second craneway, laid out on a east-west axis, is located on the eastern side of the building and extends into it near its southern end. This craneway served an adjoining billet yard.

A standard gauge track enters the building at its southern end and runs along its eastern wall. Located in a lean-to which is built on the western wall of the building near its mid-point is a billet furnace and stamping machine. A number of metallurgical hacksaws are located in the northwest corner of the building. Laying about the floor at the southern end of the building are scrap motors and rolls of rope.

Construction date: 1916

Construction of 312'-0" extension to southern end: 1920.

C. Twenty-One Inch Mill Steel Conditioning Office Building: The one-story, 33'-0" wide x 46'-0" long building is laid out on a north-south axis. It is located next to the twenty-one inch mill inspection building's western wall. Built by the American Bridge Company on a concrete foundation, the building is constructed of brick with pilasters. Segmented arch windows rim the northern, southern, and western walls of the building. A doorway to the building is located at the eastern end of its southern wall. An entrance to the cellar is located near the mid-point of the building's northern wall. The brickwork is corbelled under the eaves of its slate, gabled roof. Five office rooms are located inside of the building.

Construction date: 1901.

D. Twenty-One Inch Mill Shippers and Inspectors Office Building: Laid out on a north-south axis, the shippers and inspectors building is located just west of the twenty-one inch inspection building. The one story, 17'-0" wide x 27'-0" long building was constructed by the American Bridge Company on a concrete foundation. It is constructed of brick with pilasters. The brickwork is corbelled all around the building near its flat, corrugated metal roof. Rectangular windows rim the building's northern, southern, and western walls. A doorway is located on its north and south walls. A doorway leading to the building's cellar is located on its south wall. The building houses two offices.

Construction date: 1926.

E. Roll Shop Conditioning Yard (Formerly the Main Roll Shop): Located 158'-0" due south of the Air Compressor/Air Receiver Building, the roll shop conditioning yard is laid out on a north-south axis. Constructed on a concrete foundation by the Duquesne Works, the two story building is 55'-0" wide x 192'-0" long x 32'-0" high to the underside of the roof. A 55'-0" wide x 16'-6

1/4" long x 25'-5 3/4" lean-to is located on the south wall of the building. Brick walls encase the structure's steel framework. Fink trusses support the roll shop's wood and tar paper gable roof. A craneway spanning the width of the roll shop and running its entire length supports one 15/5-ton E.O.T. crane. Segmented arch windows rim all four walls of the roll shop and lean-to on both stories. Two large entrances are located on the northern and western walls of the roll shop (an approximately 10'-0" wide x 15'-0" high entrance on the north wall at its western end and an approximately 10'-0" wide x 20'-0" high entrance on the western wall at its southern end). Access is gained into the lean-to from the southern end of the roll shop. Located outside of the roll shop's western wall, near the entrance, are six scrap bins. A turret lathe is located inside of the roll shop along its western wall near the entrance. The rest of the roll shop consists of a storage area for spare fan housings, flywheels, transformers, and motors. The lean-to houses a tool room, washroom facilities, and offices.

Construction date: 1906.

II. <u>Primary Rolling Facilities at Lower Works</u>:

A. <u>D.P.C. Conditioning Yard Building</u>: Constructed by the American Bridge Company, the steel-framed building is 500' long x 85' wide x 42' high to the underside of the truss. It is located 33' east of the electric furnace building and is laid out on a north-south axis. Its northern end (approximately 40') runs parallel to the southern end of the electric furnace building. The building's gable roof and continuous ventilator is supported by riveted Pratt trusses. It has a corrugated metal exterior. A craneway spans the width and runs the length of the building. It supports two 25-ton E.O.T. cranes. A standard gauge railroad track runs through the building on its eastern and western side.

An electric powered mobile Mid-Western Grinder runs on rails along the eastern and western inside wall of the building at its northern end. A 300' long x 17' wide x 12' high steel-framed hot topping ingot mould platform runs along the inside eastern wall of the building at its southern end.

Two 25' long x 15' wide x 12' high corrugated metal lean-tos are built onto the outside eastern wall of the building near its northern end. Each lean-to houses a large motor and fan which draws fumes from inside of the conditioning yard building into a ventilation hood protruding through its roof.

Construction date: 1943.

Construction of 75' extension to its southern end: 1957.

B. D.P.C. Steel Conditioning Office and Storage Building: Laid out on a north-south axis, and built onto the eastern outside wall of the D.P.C. conditioning yard building at its southern end is a 220' long x 18' wide x 12' high brick lean-to. The building houses the steel conditioning office, the grinder storage room, the tool storage room, a locker room, and a wash room.

Construction date: 1943.

C. Primary Mill Building: Laid out on a north-south axis, the primary mill building is located in the lower works near the shore line of the Monongahela River. The corrugated metal clad, steel framed building was built on a concrete foundation by the American Bridge Company. It is 90'-0" wide x 2412'-0" long x approximately 70'-0" high to the underside of the truss. Its gable roof and monitor is supported by riveted modified Fink trusses. A craneway, supporting several E.O.T. cranes, spans the width and runs the entire length of the building. The building can be divided into three contiguous sections (i.e. the ingot stripper section, the soaking pit section, and the mill section itself). The building also accommodates a scale and waste water collection system.

1. Rolling Facilities:

a. Ingot Stripper Section: The ingot stripper section occupies the southern end of the building. It is 244'-0" long. The interior of the section is served by five narrow gauge tracks and one standard gauge track. The tracks enter and exit the building through its open southern end. The stripping facilities consist of two Alliance E.O.T. stripping cranes (one 50/25-ton and one 50-ton crane), each with a stripping force of 400 tons. A 1000-ton Lowey Hydropress ground stripper is located at the northern end of the stripping area on the western side of the building. The ground stripper was used to strip ingots which had become "stuck" to their moulds.

Located on the eastern side of the ingot stripper area are two narrow gauge robotic locomotives (numbers 6 and 9) and five standard gauge diesel locomotives (numbers 26, 117, 157, 461, and 810). Number 26 is labeled "Homestead Works". Seven ingot cars, each carrying an ingot mould, are also located inside of the ingot stripping section.

b. Soaking Pit Section: The soaking pit section is located just north of the ingot stripper area. It is 448'-0" long. Eight banks of soaking pit furnaces (each containing four furnaces), laid out in a single line on a north-south axis, are located near the western wall of the building. Constructed by the Swindell-Dressler Company, each of the top fired furnace pits are 9'-0" wide x 22'-0" long x 14'-9" deep. Each furnace is equipped with high velocity multi-directional burners capable of firing at a maximum rate of 20,000,000 Btu per hour, a combustion air fan, and metallic radiation recuperators which extend from the furnace to the outside western wall of the building. A motor-powered winch driven steel cover for opening and closing the furnace before and after charging of the ingots is set on top of each furnace pit. The average capacity of each furnace is 12 ingots. A large control room containing a control panel for each furnace runs the length of the line of soaking pits and is located along the western wall of the building.

Two sets of charging and two sets of delivery tracks run parallel to the pits with crossovers to provide maximum flexibility in movement within the pit area. Set on top of each delivery track is a cable-driven remote controlled ingot buggy which delivered the ingots from the pits to the mill's receiving table and overhead ingot turner. The charging or outer tracks (i.e. those furthest from the furnaces), and the delivery tracks are served by three Alliance E.O.T. cranes. Two of these cranes have a capacity of 15 tons, while the capacity of the other crane is 25/15 tons.

c. Mill Section: The mill section is located just north of the soaking pit section and makes up the northern end of the building. It is 1720'-0" long. The equipment and structures contained within the mill building are related to the primary rolling operation itself.

The machinery associated with primary rolling is laid out linearly and runs from south to north. First in line are two ingot receiving tables, each powered by a 50 hp motor. These tables received ingots from the ingot buggies before delivering them, one at a time, to the ingot shift table. The shift table was served by an overhead ingot turner and scale which was manufactured by the Mesta Machine Company. Only the housing of the ingot turner and scale, which weighed each ingot and had the capability of turning it 180 degrees, remains. From the ingot turner and scale, the ingot was passed to the 46" x 110" blooming and slabbing mill approach table which, in turn, delivered it to the mill roll stand. The 46" x 110" 2-high reversing roll stand was powered by a 5000 hp motor. It was manufactured by the Mesta Machine Company and is partially dismantled. It consists of an entry and exit table, the rollers of which were individually motor driven, and the housing for the rolls. Positioning sideguards exist both on the entry and exit ends of the roll stand. Four manipulating fingers are located on the entry end of the stand. When it was in place, the top roll had a maximum lift of 70" with a maximum screw speed of 600" per minute. Product sizes from the 46" mill included up to 52" wide slabs with a minimum thickness of 3 1/2", bloom sizes up to 20" square and various breakdown sizes for subsequent rolling in the 36" mill. Product sizes down to 8" square could also be finished on the 46" mill when the 36" mill was rolling smaller sections.

Following the exit end of the remains of the 46" mill roll stand, is a 78'-9" long mill run-out table. This table delivered the bloom or slab to the 63'-8" long scarfer delivery table. The scarfer, manufactured by the Linde Division of the Union Carbide Corporation, is dismantled. By using a constant supply of air, fuel gas, and oxygen as cutting agents, it was capable of "scarfing," or removing surface defects on the bloom or slab at its edges only, top and bottom only, or on all four sides. An electrical precipitator, located due east of the scarfer on the outside eastern wall of the south motor room, cleaned waste gases from the scarfer.

After passing through the scarfer, the bloom or slab moved to the 60'-5" long shear approach and entry table. The 46" x 110" mill shear was manufactured by the Mesta Machine Company. The electrically driven, up-down cut type shear, was powered by four 500 hp motors. It was capable of shearing blooms or slabs with a maximum thickness of 22" to a maximum length of 20'-0" and a minimum length of 6'-0". Crops from the shear were directed through scrap chutes into one of two 21-ton skip hoists which are located in a pit just west of the shear in the scrap and scale building. The skips eventually dumped the crops into charging boxes which were transferred to the plant's steelmaking facilities where the crops were used as revert scrap.

Next in line is the 46" x 110" mill slab piler and transfer. The outlet for slabs and larger bloom sizes which were finished on the 46" mill, the elevator type piler was capable of piling to a maximum height of 3'. It placed the slabs or blooms on a transfer car which travelled to the shipping building and were unloaded by a "C" hook equipped crane. On the north side of the piler is a pneumatic impact stamping machine. Operated by the piler-transfer operator, the machine was used to stamp identifying numbers on each slab or bloom.

Blooms which were slated to be rolled into smaller sizes passed directly from the 46" x 110" mill shear to the 36" x 78" 2-high reversing blooming mill. Manufactured by the Birdsboro Company and powered by two 3000 hp motors, the mill was capable of producing blooms or billets in square or round shapes ranging in size from 15" to 4 9/16". Only the housing for the rolls remains in place. The top roll, when in place, had a maximum lift of 40" and a maximum screw speed of 400" per minute.

The 1000 ton 36" mill shear is next in line. The open-sided shear was electrically driven through an air operated clutch and flywheel combination. Crops from the shear were directed to chutes into one of two self dumping boxes which are set in a pit on the western side of the shear. The sheared product requiring no further rolling was pushed onto a rope-driven transfer table which is located just north of the shear on its western side. The table transferred the blooms to the shipping building where they were unloaded by a "C" hook equipped crane.

A 72" hot saw is located just north of the 36" mill transfer. Used for securing metallurgical tests, blooms were routed to the saw by means of an air operated diverter which could also return them to the transfer table after testing.

Next in line is the 21" mill transfer table. The electric powered table, which is partially dismantled, diverted products in need of further working from the 36" mill to either the hot saw line on the western side of the building or to the 21" continuous billet mill on the eastern side of the building. Blooms requiring perfectly level ends were diverted to the hot saws. These included square blooms that were to be shipped to customers for subsequent forging and rounds which were used to make seamless pipe. The completely intact hot saw line consists of four rotary saws laid out in two lines--one stationary saw and one travelling saw in each line. Built by the United Engineering and Foundry Company, each saw was powered by two 800 hp motors. The length of travel of the travelling saws was 32'. The range of lengths that each saw was able to cut was from 10' to 32'.

The 21" continuous billet mill is also completely intact. First in line is a 175-ton electric powered swinging crop shear. It was used to crop the front end of the entering bloom. The crops were directed into a pit on the western side of the line by means of a chute to a crop bucket which was removed periodically by crane. Following the crop shear is an air-operated billet turner which rotated blooms on the diamond for entry into the first pass of the mill. The 21" x 42" continuous billet mill, which is next in line, is a 4-stand mill with alternate vertical and horizontal rolls. Each stand is powered by a 1500 hp motor. Manufactured by the United Engineering and Foundry Company, the mill produced billets ranging in size from 1 3/4" to 4 9/16" square.

Following the continuous billet mill is the electric powered, 137.5-ton, 21" flying shear. Built by the Morgan Construction Company, the shear cut the billets into lengths from

12' to 32'. Crops from the shear fell through a chute into a crop bucket which was located in a pit on the western side of the flying shear.

A double skew gathering table is located immediately past the 21" flying shear. It was used to collect the billets in gangs after shearing. The skew table segregated the billets by size and type. Short pieces--billets, usually one per ingot, which formed the remainder of the ingot and which consequently could not be cut into the proper length--were flipped off of the skew table by a short piece ejector into a cradle.

From the skew gathering table, the billets were moved to a rope driven transfer table which in turn moved them westward to the hot bed run-in table. Product from the hot saw line was also moved to the hot bed run-in table by a rope driven transfer table. The run-in table delivered the billets to one of three hot beds which were laid out perpendicular to the 21" mill line. The rope driven hot beds ran in a westerly direction and dropped the cooled billets into a cradle that is located in the shipping building. The billets were subsequently picked up by an E.O.T. crane and piled for shipping.

2. <u>Scale and Waste Water Collection Facilities</u>: The scale and waste water collection system at the primary mill building begins in the soaking pit section. A 20' deep concrete pit running directly underneath the ingot car buggy tracks collected loose scale which dropped from the ingots that were being transferred from the soaking pits to the ingot receiving table. The pit was periodically cleaned out by a cable-drawn scale bucket which travelled along the bottom of the trough, and carried the scale to the southern end of the soaking pit section up a slight incline and into a cinder box. The box was subsequently moved by means of an electric platform truck to a cinder pit, located outside of the eastern wall of the soaking pit section. From there, the contents of the box, and others like it, were periodically dumped into a railroad car or truck.

An extensive scale and waste water system of flumes is located in the basement of the building's mill section, directly beneath the rolling equipment. It is divided into three sections. The first section covers the 46" x 110" mill area. The flume extends from the ingot receiving table to the 46" mill shear. It collected the scale and waste cooling water slurry from the receiving table, the 46" x 110" roll stand, the hot scarfer, and the 46" mill shear. The flume is sloped from each end so that the slurry flowed downward to its center which is located directly below the 46" x 110" roll stand. From there the flume extends westward at a slope of 9 degrees to Scale Pit No. 1

which is located outside of the western wall of the building in the scrap and scale yard. The 103' long x 28' wide x 49' deep scale pit is divided into three separate stilling chambers. The accumulated solids in each of the chambers were periodically cleaned out by a clam bucket which was operated by an E.O.T. crane. In addition, the middle chamber contains a rope skimmer which was used for the removal of floating oil. The oil was subsequently squeezed from the rope and collected in 55-gallon drums. The third chamber of Scale Pit No. 1 contains four vertical pumps. All waste water from Scale Pit No. 1 as well as from Scale Pit Nos. 2 and 3 was directed to this chamber where it was pumped over to the waste water treatment facilities which serviced the works' rolling mills.

The second section of the flume system covers the area between the 46" mill shear and the 36" mill shear. The design of both the flume and Scale Pit No. 2 are similar to the No. 1 system. Partially treated waste water from Scale Pit No. 2, which is located in the scrap and scale yard opposite the 36" mill, flowed by gravity from its third chamber through a sewer to the third chamber of Scale Pit No. 1.

The third section of flumes covers the entire lower end of the mill beginning at its hot test-saw area. It consisted of a series of interconnecting flumes which serviced the 21" mill, hot-saw lines, transfer beds, skew tables, and all other facilities in the area. As with the first and second sections of the flume system, waste water from the flumes flowed into Scale Pit No. 3 located outside of the western wall of the building in the scrap and scale yard. Waste water from Scale Pit No. 3, like Scale Pit No. 2, flowed by gravity from its third chamber through a sewer into the third chamber of Scale Pit No. 1.

Construction of Building, Rolling Facilities, and Flume System: 1959.
Addition of vertical pumps at Scale Pit No. 1: 1981.

D. South Motor Room: The 672' long x 60' wide south motor room is a sheet metal lean-to off of the eastern wall of the primary mill building in line with the 46" x 110" mill and the 36" x 78" mill. It is laid out on a north-south axis. Constructed by the American Bridge Company on a concrete foundation, the steel-framed building is approximately 60' high. It consists of a ground floor and basement. Warren trusses support the building's slanted roof. A craneway spanning the width of the building and extending its entire length supports a 60-ton E.O.T. crane. In order to provide access for this crane to service the adjacent roll shop, the building has no northern wall.

Located in the basement of the building are a series of fans. The fans were designed to circulate air through vents leading to the ground floor in an effort to keep dust out of the building.

The ground floor of the building contains the motors and motor-generator sets which powered the machinery and other equipment that was affiliated with the 46" x 110" mill and the 36" x 78" mill. The 5000 hp motor which powered the 46" mill, and the two 3000 hp motors that powered the 36" mill, have been removed. All electrical equipment was manufactured by the General Electric Company.
Construction date: 1959.

E. North Motor Room: Laid out on a north-south axis, the 240' long x 45' wide north motor room is a sheet metal clad lean-to off of the eastern wall of the primary mill building in line with the 21" continuous billet mill. Approximately 50' high, the steel-framed building was constructed by the American Bridge Company on a concrete foundation. It consists of a ground floor and basement. Warren trusses support the building's slanted roof. A craneway spanning the width of the building extends its entire length, and supports a 50-ton E.O.T.crane.

Located in the basement of the building is a Bowser forced oil lubricating system for the billet mill. An accumulator is also located in the basement. It was used to keep the rolls in contact with their respective screw down mechanisms. Four cooling water pumps for the billet mill are also located in the basement.

The ground floor of the building contains the motors and motor generator sets which powered the machinery and other equipment that was affiliated with the 21" continuous billet mill. This equipment is completely intact. All electrical equipment was manufactured by the Elliot Company.
Construction date: 1959.

F. Scrap and Scale Yard: Laid out on a north-south axis, the 1720' long x 70' wide scrap and scale yard is adjacent to the western wall of the mill section of the primary mill building. The corrugated metal clad, steel-framed building was built on a concrete foundation by the American Bridge Company. It is approximately 70' high to the underside of the truss. In order to provide access to the primary mill and shipping buildings, the scrap and scale yard has no eastern or western walls. Its gable roof and monitor are supported by riveted Fink trusses. A large portion of the roof at the middle of the building has been removed. A craneway spans the width and runs the entire length of the building. It supports two 40-ton E.O.T. cranes and one 10-ton E.O.T. crane.

Located along the eastern side of the scrap and scale yard are the scale pits discussed above (see Scale and Waste Water Collection Facilities). Also located inside of the building are sixteen approximately 30' long x 6' wide slow cool furnaces, two stationary flame cutters, and a slab scarfing bed. Eleven slow cool furnaces are located near the middle of the building on its eastern side. The other five are located at the northern end of the building near its western side. The stationary flame cutters and scarfing bed are located near the middle of the building on its eastern side.
Construction date: 1959.

G. Shipping Building: The 1296' long x 86' wide x approximately 70' high shipping building is adjacent to the western side of the scrap and scale yard. It is laid out on a north-south axis. Built on a concrete foundation by the American Bridge Company, the northern wall of the steel-framed corrugated metal building is even with the northern wall of the scrap and scale yard. In order to provide access to the scrap and scale yard, the building has no eastern wall. Its gabled roof and monitor is supported by riveted Fink trusses. A craneway spans the width of the building and runs its entire length. It supports four 40-ton E.O.T. cranes. A standard gauge railroad track enters through an opening at the southern wall of the building and runs along its entire western side before leaving through an opening at the northern wall of the building.

Six approximately 30' long x 6' wide slow cool furnaces are located near the middle of the building on its eastern side.
Construction date: 1959.

H. Roll Shop: Laid out on a north-south axis, the 120' long x 60' wide roll shop is built as a lean-to off of the eastern wall of the primary mill building just north of the south motor room. Constructed by the American Bridge Company on a concrete foundation, the steel-framed building is approximately 60' high to the underside of the truss. It has a wood block floor. Warren trusses support the building's slanted roof. A craneway spans the width of the building and runs its entire length. In order to provide access for the 60-ton E.O.T. crane which also services the south motor room, the roll shop has no southern wall. A standard gauge railroad track, running in an east-west direction, carries a cable driven roll transfer buggy.

The equipment inside of the roll shop includes a Baldwin-Lima-Hamilton 50" Niles contour lathe for dressing rolls; a

Standard Electrical Tool Company 20" tool grinder for sharpening the lathe's carbide tools; a Hammon Chip Breaker Grinder for the carbide tools of the lathe; a Thomas Metal Master Disintegrator for branding the dilok trade mark into the rolls; a Planet Roll Grooving Machine for making dilok grooves; a Delta Rockwell tool grinder for the carbide tools of the dilok grooving machine; a Standard Electrical Tool Company grinder for rough grinding; a Clausing drill press for small holes; and a Delta Rockwell 7" grinder for sharpening drills for the drill press.
Construction date: 1959.

I. Spare Shed: Laid out on a north-south axis, the approximately 100' long x 45' wide spare shed is built as a lean-to off of the eastern wall of the primary mill building. Approximately 50' high, the steel-framed building was constructed on a concrete foundation by the American Bridge Company. The northern wall of the spare shed is shared in common with the southern wall of the north motor room. Warren trusses support the building's slanted roof.

Located inside of the building are storage racks which were used to store spare parts for the primary mill.
Construction date: 1959.

J. Control Room: Laid out on a north-south axis, the 56' long x 24' wide control room is a lean-to off of the eastern wall of the primary mill building. Approximately 50' high, the steel-framed building was constructed on a concrete foundation by the American Bridge Company. Its southern wall is shared in common with the northern wall of the north motor room. Warren trusses support the building's slanted roof. All equipment inside of the control room has been removed.
Construction date: 1959.

K. Saw Sharpening Room: The 56' long x 22' wide saw sharpening room is laid out on a north-south axis. The corrugated metal building is a lean-to off of the eastern wall of the primary mill building. Approximately 50' high, the steel-framed building was built on a concrete foundation by the American Bridge Company. Its southern wall is shared in common with the northern wall of the control room. Warren trusses support the building's slanted roof. Two 1,000 lb. capacity monorail cranes (one electrical and one ratchet type) extend the length of the building.

The equipment inside of the saw sharpening room includes two South-Hanchett Saw Sharpening Machines for sharpening the hot saw blades of the primary mill and the 22" bar mill; a No. 1 Motch and Merryweather Automatic Saw Sharpening Machine for the Bonnet

cold saw blades of the 21" conditioning yard; and a Rogers Shear Knife Grinder for sharpening the shears at the primary mill.
Construction date: 1959.

L. Production Planning and Blooming Mill Office: Laid out on a north-south axis, the 192' long x 49' wide, one story building is located 265' south and 45' west of the shipping building. Built on a concrete foundation by the American Bridge Company, the steel-framed production planning and blooming mill office is made out of sheet steel and has a flat roof. Located inside of the building are several offices.
Construction date: 1959.

HISTORY

The process of rolling steel essentially consists of passing the material one or more times between two rolls revolving at the same peripheral speed in opposite directions. Spaced so that the distance between them is somewhat less than the height of the section entering them, the rolls sit in a large housing and are driven by a steam engine or electric motor which transfers power through pinions and spindles. As the steel passes through, the rolls grip the piece of metal and deliver it reduced in section and increased in length in proportion to the reduction except for a slight lateral spreading. The size and shape to which the steel conforms is determined by the shape of rolls and by a screwdown mechanism located at the top of the roll housing that adjusts the distance between the rolls.[1]

Primary rolling consists of reducing steel ingots to manageable shapes prior to their further reduction into semi-finished bars or finished products. These shapes take the form of slabs, blooms, or billets. Primary rolling at Duquesne began with the installation of a 32" reversing blooming mill in 1889. This mill rolled Bessemer ingots into blooms prior to their being finished at the rail mill. After the Carnegie Steel Company purchased the works in 1890 the production of steel rails was discontinued and the 32" mill was dismantled. The rail mill was converted into a billet/sheet bar mill composed of a 28" 3-high roughing stand and two 21" roll trains each consisting of 3 roll stands. A 38" reversing blooming mill was constructed in 1894 to provide blooms for the billet/sheet bar mill. These facilities were augmented in 1900 by the construction of new 40" reversing blooming mill followed by a 14" continuous billet mill. The following description of the operation of the 40" blooming mill and the 14" continuous billet mill is provided as a typical example of primary rolling at Duquesne until the late 1950s.[2]

The 40" reversing blooming mill/ 14" continuous billet mill complex was laid out linearly on a north-south axis near the northwest corner of the upper works. The process began when wholly or partially solidified steel ingots were stripped from their moulds by an overhead stripper crane and subsequently charged into one of eleven regenerative soaking pit furnaces. The gas fired soaking pits or deep chamber furnaces were utilized in such a manner as to ensure that the entire ingot reached a uniform rolling temperature. A single pit furnace was made up of four holes capable of accommodating four ingots. After a period of one to six hours, depending on its metallurgical composition and its temperature upon charging into the furnace, the ingot was lifted by an E.O.T. crane from the pit and placed into a motor powered pot car which delivered it by rail to the 40" mill entry table.

The 84' long entry table, consisting of a number of 12" diameter solid transfer rollers powered by a 50 hp motor, delivered the ingot to the 40" roll stand. The rolls themselves were grooved into five shapes and were powered by a Mackintosh-Hemphill 44" x 70" x 66" twin tandem compound condensing steam engine. The ingot was passed back and forth through the rolls for as many as nineteen passes before it was reduced in cross-section to a size ranging from a 22" x 2" slab to a 4" x 6" bloom. The machinery governing the operation of the entry table and roll stand was controlled by men located in a pulpit above the roll stand.

After the rolling was complete, the material passed to the number one shear table which lay immediately beyond the 40" mill delivery table. From the shear table the section was passed through a hydraulic shear. This shear was intended for cropping the ends of the material that may have split from being rolled, and to serve as a back-up shear in the event that the adjacent steam driven shear was not in operation. The steam driven shear, powered by a Mackintosh-Hemphill 18" x 20" vertical steam engine, cut the blooms or slabs into specified lengths.

Following the shearing operation, the product was passed over the rear shear table onto the adjacent loading table. An adjustable and removable stop placed at the end of the loading table, stopped those pieces that were slated to be loaded in the shipping yard. A steam driven pusher subsequently moved the pieces for shipping across the loading table and down an incline onto rail cars. If blooms were slated to be rolled down into smaller billet shapes, the stop was raised and the blooms were passed directly onto the entry table of the 14" continuous billet mill. The motors which powered the rear shear table and the loading table were controlled by an operator located on an elevated platform with a clear view of all the machinery. This operator also controlled the removable stop, the steam driven pusher, and the car pusher which spaced and shifted the rail cars in front of the loading chute opposite the loading table.

The 14" continuous billet mill consisted of 10 roll stands connected by a single drive shaft to a 44" x 78" x 60" Corliss vertical compound condensing steam engine with a rated 3500 hp. Between the entry table of the mill and the first stand of rolls, there existed a set of hydraulic shears through which all blooms for the 14" continuous mill passed. They were used to cut crops from the front end of the bloom so that it would enter stand No. 1 easily. Each of the blooms to be rolled entered the first stand and travelled in a straight line through the last stand of the mill where it was reduced to a billet ranging in size from 3" to 1 1/2" square. Only one pass was made through each stand of rolls. Because the speed of travel of the bloom and hence the speed of the rolls increased at each succeeding stand, the roll housings were spaced at increasingly closer intervals so as to prevent the material from buckling as it was being rolled.

After the billet had passed through roll stand No. 10 it was delivered to the steam driven flying shears where it was cut into specified lengths. From the flying shears the billets passed to the skew-roll assembly table where all of the billets from one ingot lined themselves up side by side. A pusher subsequently delivered the entire group of billets onto one of four hot beds which were located at right angles to the skew-roll gathering table. Stream driven pushers slowly moved the billets across the slightly sloping 31' wide x 53'-6" long hot bed until the cooled billets were conveyed over its end into rail cars that were located in the shipping yard just below the hot bed level. From the shipping yard, the billets were delivered to an inspection station where they were examined for surface defects. Those found defective were shipped to a conditioning area where the defect was removed by means of hand chipping, grinding, or scarfing.[3]

The equipment described above was installed at the Duquesne Works in the late nineteenth and early twentieth centuries and served the primary rolling needs of the mill until 1959. In that year the new primary rolling mill, explained above in the description section, was constructed and the old facilities were dismantled.[4]

<u>ENDNOTES</u>:

1.J. M. Camp & C. B. Francis, <u>The Making, Shaping, and Treating of Steel</u>, Fourth Edition, (Pittsburgh: 1925): 435.

2."New Works of the Allegheny Bessemer Steel Company," American Manufacturer 44 (January 25, 1889): 467; Carnegie Steel Company, "Duquesne Works: Plant Description Book," (Duquesne, 1925), 72, 75, 76, 84 & 85; "The Duquesne Works of the Carnegie Steel Company - I," The Iron Age 71 (January 1, 1903): 12 - 20.

3.Camp & Francis, The Making, 484-93, 516-24; "The Duquesne Works of the Carnegie Steel Company - I," 19 - 20; Carnegie-Illinois Steel Corporation, Steel Plant Design: Rolling Mills, Vol. III, (Pittsburgh: 1945): L1 - L25.

4."New Primary Mills at the Duquesne Works, United States Steel Corporation," Iron and Steel Engineer 40 (June 1963): 80-86.

Historic Name: U.S.S. Corporation, Duquesne Works, Rolling Mills, Bar Rolling Systems
Present Name: U.S.X. Corporation, Duquesne Works, Rolling Mills, Bar Rolling Systems
Location: Lower Works
Construction: 1906, and ca. 1940
Documentation: All photographs of the Primary Mills are located in HAER No. PA-115-D. Photographs of the Twenty-Two Inch Bar Mill (No. 5 Mill) are located in HAER No. PA-115-G.

DESCRIPTION

I. Twenty-Two Inch Bar Mill (No. 5 Mill):

A. Bloom Yard: The 66'-8" wide x 209' long bloom yard is laid out on a north-south axis and is located approximately 160' northeast of the electric furnace building. A steel-framed overhead craneway running the length of the bloom yard supports a 15-ton E.O.T. crane. Billets which were rolled at the primary mill were stored in the bloom yard prior to being rolled into bars.

Construction date: 1906.

B. Pre-Heating Furnace Building: Laid out on a north-south axis, the one-story, 71'-10" wide x 128' long preheating furnace building is adjacent to the bloom yard. The riveted steel-framed, corrugated metal clad building was built upon a concrete foundation by the American Bridge Company. Its gable roof and monitor are supported by riveted Fink trusses. A 15-ton E.O.T. crane rests on top of a craneway spanning the length of the building.

Located inside of the building at its southern end is a Loftus Continuous Preheat Furnace. The furnace, which operated on mixed fuel and was capable of heating billets to 1500° F, has a 18' wide x 39' long hearth. Billets entered the southern end of the furnace and were discharged from its northern end onto a cable driven flat transfer car on standard gauge rails. Two large motor driven fans, located near the western wall of the building, provided combustion air to the furnace. Waste gas from the furnace was conducted through a large brick flue stack located just outside of the western wall of the building.

Construction date: ca. 1940.

C. Batch Furnace Building: The one-story, 82' wide x 176' long batch furnace building is laid out on a north-south axis. Constructed by the Duquesne Works on a concrete foundation, the riveted steel-framed building is located just north of, and in line with, the pre-heating furnace building. In order to provide a clear passageway into the pre-heating furnace building and the 22" bar mill building, the batch furnace building consists of an open northern and southern end. The western wall of the building is constructed of brick. The eastern wall of the building has been removed and replaced by a corrugated metal lean-to. Three rows of segmented archway windows run along the building's western wall. The building's corrugated metal roof and monitor are supported by Fink trusses.

Three regenerative batch furnaces are laid out near the inside western wall of the building. Constructed of brick and equipped with six steel charging doors, each of the regenerative furnaces has a 18' wide x 36' long hearth. Located just south of the line of regenerative furnaces are three large motor driven combustion air fans (one for each furnace). Three large steel waste gas flue stacks are located just west of each regenerative batch furnace and extend through the roof of the building. Set inside of the lean-to along the eastern side of the building are two non-regenerative batch furnaces. Constructed of steel and equipped with two charging doors, each of the non-regenerative furnaces has a 22' wide x 24' long hearth. One large motor driven combustion air fan per furnace is located between the two non-regenerative batch furnaces. One large steel waste gas flue stack per non-regenerative batch furnace is located just outside of the eastern wall of the lean-to. Both types of furnaces operated on mixed fuel and were capable of heating billets to temperatures ranging from 1500° to 2300° F.

Located at the northern and southern end of the building is an overhead structural steel runway extending across the building in an east-west direction. A 5-ton mobile Morgan charging machine is suspended from each runway. The machines removed billets from the transfer car and charged them into one of the batch furnaces. After the billets had been heated to rolling temperature, one of the charging machines removed them from the furnace and placed them, one at a time, onto the 3' wide x 110' long electric motor driven bloom delivery table. The billets were conveyed along the delivery table to the descaler, located at the southern end of the 22" bar mill building.

Construction date: 1906.

Installation of non-regenerative batch furnaces: ca. 1940.

D. Twenty-Two Inch Bar Mill Building: The one story, 22" bar mill building is approximately 70' wide x 430' long. Laid out on a north-south axis, the building is adjacent to the northern end of the batch furnace building. Constructed on a concrete foundation by the Duquesne Works, the riveted steel-framed building is open at its northern and southern end in order to provide a clear passageway to the batch furnace building and the bar stocking and finishing building. The eastern and western walls of the building are constructed of brick. Three rows of segmented archway windows run along the western wall of the building. The building's corrugated metal roof and monitor are supported by Fink trusses. A 25/5-ton capacity E.O.T. crane rests on top of a craneway running the length of the building.

The extant equipment and structures inside of the building make up the rolling facilities for the 22" bar mill and the scale and waste water collection system. The following integrates a description of the extant equipment in the rolling facilities and the scale and waste water collection system with a statement of their function.

1. Rolling facilities: With the exception of one die rolling 22" finishing roll stand, the equipment making up the 22" bar mill is laid out linearly near the eastern wall of the building. The mill ran from south to north. First in line is the descaler which is located at the southern end of the building. Consisting of an approximately 6' wide x 4' long x 3' deep, three sided 1/4" thick steel plate frame that covers a series of water jets, the descaler removed scale from each billet which had been transferred from the batch furnaces to the bloom delivery table.

After passing through the descaler, each billet was conveyed onto the entry table of the United 3-high 28" roughing roll stand. The entry and exit tables of the roll stand were hydraulically raised and lowered as each billet was passed back and forth on the table's electric motor powered rollers through the stand's upper and lower set of rolls. Three motor powered hydraulic pumps, used for activating the entry and exit tables of the 28" roll stand, are located in an approximately 20' wide x 100' long x 10' high corrugated metal shanty located just west of the roll stand.

After several passes through the 3-high roughing stand, the bars were conveyed onto a 63'-2" long motor powered movable travelling table. The table, which is set on top of rails running in an east-west direction, delivered the bars to one of two United 22" 2-high reversing finishing stands. The finishing stands are laid out linearly on an east-west axis, approximately 30' apart. One finishing stand is directly south of the 28" roughing stand near the eastern wall of the building. The other finishing stand was used only in the production of die rolled products. The bars were finished into round cross-sections ranging from 2 5/8" diameter to 9 1/2" diameter, into square cornered square cross-sections ranging from 2 3/16" to 6 1/16", and into round cornered square cross-sections ranging from 2 5/16" to 7 1/2".

Finished bars were transferred from one of the two 22" finishing stands to another 63'-2" long movable travelling table. Arranged in the same manner as the travelling table discussed above, the table delivered the bars to the 60' long approach table of the United hot saw. The motor-powered hot saw cut the bars into lengths ranging from 10' to 48'. After passing through the hot saw, the bars were conveyed alongside the mill's 50' wide x 45' long hot bed by the motor powered rollers of the 112'-6" long hot bed entry table. Upon reaching the hot bed, the finished bars were transferred onto it by an electrically operated beam pusher. The cable driven hot bed slowly moved the finished bars from the eastern to the western side of the building where they dropped off onto the electrically driven rollers of an 353'-3" long run-out table extending through the bar stocking and finishing building as well as shipping buildings no. 1, 2, and 3.

2. Scale and Waste Water Collection System: A continuous flume system beneath the descaler and the roll stands collected scale and contact water and delivered it to the mill's scale pit. Contact water consists of water used at the descaler and water used to cool the rolls while they are operating. The approximately 10' wide x 18' long x 25' deep scale pit is located between the 28" roll stand and the corrugated metal shanty housing the hydraulic pumps. Waste water entered it from the bottom and rose slowly, thus allowing suspended solids in the form of scale and particulate to settle out at the bottom of the pit. These solids were periodically cleaned out of the scale pit by a clam bucket which was attached to the E.O.T. crane. Suspended solids in the waste water from the hot saw were settled out into a hot saw solids trap. Solids in this trap were periodically cleaned out by a clam bucket that was attached to the E.O.T. crane. The partially cleaned waste water from the scale pit flowed by gravity through a sanitary sewer to the bar mill lift station.

The 31'-10" long x 27'-10" wide x 40'-0" deep bar mill lift station is located just outside of the western wall of the 22" bar stocking and finishing building. The lift station provides for gravity settling and pumping. Four vertical pumps are located inside of the lift station. Two pumps (one operating and one standby) provided approximately 3000 gallons per minute of water to flush the flume system while the other two pumps delivered about 1200 gpm to the clarifier at the waste water treatment facilities for the primary and bar mills.

Construction of building: 1906.

E. Twenty-Two Inch Bar Mill Motor Room: The one-story 224' long x 35'-5" wide 22" bar mill motor room is constructed of brick. Laid out on an north-south axis, it is built as a lean-to off of the eastern side of the 22" bar mill building in line with the roughing and finishing stands of the bar mill. Constructed on a concrete foundation by the Duquesne Works, the building's steel framework is encased in its brick walls. One row of rectangular windows is evident along the eastern wall of the building. The building's corrugated metal slanted roof is supported by small I-beams running in a north-south and east-west direction. Two ventilation hoods protrude through the eastern side of the roof near the middle of the building. A craneway spanning the width of the building, and extending across its entire length, supports a 25-ton E.O.T. crane.

Located near the southern wall of the building and laid out on a east-west axis is the 1600 hp Westinghouse motor and Falk gear drive for the 3-high roughing roll stand. The roll stand is located in the 22" bar mill building on the other side of the motor room's western wall. It is connected to the motor/gear drive assembly by a line shaft. The motor/gear drive assembly was served by a Bowser Lubrication system which is located just south of it in the cellar of the building.

Located just north of the motor/gear drive for the 3-high 28" mill near the eastern wall of the building is a Type 4 Westinghouse Automatic Slip Regulator. Just north of the slip regulator along the eastern and western wall of the building are two (one each) electrical breaker boxes. The box along the eastern wall is approximately 20' long x 5' wide x 10' high. The box along the western wall is about 20' long x 2' wide x 8' high. Both boxes contain breaker switches for the various types of electrical equipment located in the building.

A 20' long x 10' wide x 15' high enclosed room is built off of the inside eastern wall near the mid-point of the building just north of the above mentioned breaker box. It contains two large motor/fan assemblies which are used to exhaust air through the ventilation hoods protruding through the roof of the building. Opposite the motor fan room near the inside western wall of the building is a motor-generator set which is laid out on a north-south axis. It consists of a 1500 hp Westinghouse Synchronous motor, flanked on either side by a Westinghouse D.C. generator. The generator on the southern side of the motor has a rating of 15 kw, while the generator on the northern side of the motor has a rating of 1250 kw. Located just north of the above mentioned motor-generator set, also near the inside western wall of the building, is a smaller motor-generator set that is laid out on a north-south axis. It consists of a 50 hp Westinghouse Type CX motor flanked on its southern side by a 5 kw Westinghouse D.C. generator. On the northern side of the motor are two Westinghouse D. C. generators each with a rating of 5 kw.

Located just north of the motor-generator sets and laid out on a east-west axis is the 1250 hp Westinghouse D.C. reversing mill motor and gear drive for the 22' finishing roll stands. These roll stands are located in the 22' bar mill building on the other side of the western wall of the bar mill motor room, and are connected to the motor/gear drive assembly by a line shaft. A Bowser forced lubrication system for the motor/gear drive assembly of the 22" finishing roll stands is located just to the north in the cellar of the building.

Located just north of the lubrication system and sitting on the ground floor of the building along its inside western wall is another motor-generator set. Laid out on a north-south axis, the unit consists of one 65 hp General Electric Tri-Clad Induction motor flanked by one 50 kw General Electric D.C. generator.
Construction date: 1906.

F. Twenty-Two Inch Bar Stocking and Finishing Building: The one story, 90' wide x 520' long bar stocking and finishing building is laid out on a east-west axis. Constructed by the Duquesne Works on a concrete foundation, the riveted steel-framed building is adjacent to the north side of the 22" bar mill building and the heat treatment building. There is a large opening at its northern and southern ends so as to provide a clear passageway to the bar mill building and heat treatment building on its south and to the 22" shipping building No. 1 to its north. The gable roof of the corrugated metal building is supported by Fink trusses. Two 25-ton, and one 15-ton E.O.T. cranes sit on top of a craneway which spans the width and runs the entire length of the building.

Located inside of the building, next to the hot bed run-out table is a Kron cradle type floor scale. Approximately 10' east of the run-out table and floor scale are eight 35' long x 6'-2" wide x approximately 4' deep slow gas-fired cooling pits which are laid out on a north-south axis in two rows. The purpose of slow or 'controlled' cooling is to prevent ruptures which occur in recently rolled bars when they are allowed to cool at room temperatures.

Located near the inside eastern wall of the building and laid out on a north-south axis are three open-topped pickling vats. Made out of acid resistant brick, the two vats closest to the wall are approximately 5' wide x 50' long x 6' deep. The vat farthest from the wall is approximately 5' wide x 60' long x 6' deep. After cooling, bars were routinely immersed in the sulfuric acid solution contained within the vats. This process made it possible to thoroughly inspect the bars for defects because it removed surface scale from them. Once identified, the defects were removed from the bars at one of the conditioning buildings. Two large sulfuric acid storage tanks are located near the southeastern corner of the building just outside of its southern wall.

Two rail heads running in a north-south direction through the 22" bar mill shipping buildings No. 1, 2, and 3, end in the bar stocking and finishing building. One rail head is located between the slow cool pits and the pickling vats, the other is located at the western end of the building.
Construction date: ca. 1942.

G. Twenty-Two Inch Bar Mill Shipping Building No. 1: Laid out on an east-west axis, the one story, 65' wide x 480' long 22" bar mill shipping building was constructed by the Duquesne Works. Built on a concrete foundation, the riveted steel-framed building is adjacent to the north side of the 22" bar stocking and finishing building. Its north and south ends are open in order to provide a clear passageway to the bar stocking and finishing building to its south and to the shipping buildings no. 2 and 3 on its north. The building's gable roof is supported by Fink trusses. Three 20-ton E.O.T. cranes are on top of a craneway which spans the width of the building and runs its entire length.

Located inside of the building just north of the eight slow cooling pits in the bar stocking and finishing building are four more slow cooling pits. Three of these pits are 6' wide x 42' long x approximately 4' deep. The other pit is 6' wide x 52' long x approximately 4' deep. Located just west of the slow cooling pits next to the hot bed run-out table is a Kron cradle type floor scale.

Part of a Sutton bar straightening machine is located at the far western end of the building just east of the rail head. Laid out on a north-south axis, the straightening machine also occupies space in the 22" bar shipping building no. 2. It had the ability to straighten bars from 2 1/2" to 10" in cross-section x 10' to 50' in length at a rate of between 100 to 150 tons per eight hour turn.
Construction date: ca. 1942.

H. Twenty-Two Inch Bar Mill Shipping Building No. 2: Laid out on a east-west axis, the one story, 61' wide x 480' long 22" bar mill shipping building No. 2 was constructed by the Duquesne Works on a concrete foundation. It is adjacent to shipping building No. 1. The building is open on its northern and southern ends in order to provide a clear passageway to shipping building No. 1 to the south, and shipping building No. 3 to the north. Its gable roof is supported by Fink trusses. Three 20-ton E.O.T. cranes sit on top of a craneway which spans the width of the building and extends its entire length.

Located inside of the building next to the western side of the hot bed run-out table is a Kron cradle type floor scale. The northern portion of the Sutton bar straightener is located in the far western end of the building near the rail head.
Construction date: ca. 1942.

I. Twenty-Two Inch Bar Mill Shipping Building No. 3: The one story, 80' wide x 480' long 22" bar mill shipping building No. 3 is laid out on a east-west axis. It is adjacent to shipping building No. 2. Built on a concrete foundation by the Duquesne Works, the building is open on its southern end in order to provide a clear passageway to shipping building No. 2. Its gable roof is supported by Fink trusses. Three 20-ton E.O.T. cranes sit on top of a craneway which spans the width of the building and runs its entire length.

Located inside of the building next to the western side of the hot bed run-out table is a Kron cradle type floor scale. All other equipment formerly in the building has been removed.
Construction date: ca. 1942.

J. Oil Storage Shed, Paint Shed, Locker Room, and Twenty-Two Inch Bar Mill Shipping Office: The oil storage shed, paint shed, locker room, and 22" bar mill shipping office are located just outside of the northern wall of shipping building No. 3. The approximately 10' square x 10' high corrugated metal oil storage shed is located near the northwest corner of the shipping building. It contains six 4' square x 6' high oil tanks.

About 50' east of the oil storage shed is the approximately 10' wide x 20' long x 20' high corrugated metal paint shed. Laid out on a east-west axis, it has a gable roof.

The locker room is located approximately 15' east of the paint shed. Laid out on a east-west axis, it is 30' wide x 80' long x 15' high. Constructed on a concrete foundation, the building is made out of concrete block and has a flat roof.

About 150' east of the locker room is the 15' wide x 30' long x 15' high 22" bar mill shipping office. Constructed on a concrete foundation, the corrugated metal building is laid out on a north-south axis. Its gable roof is supported by Pratt trusses. The building is divided into two rooms. The southern room contains a small Panner Bros. stamping press in the western corner of the room. Inside of the northern room are four desks and three lockers.

Construction dates: ca. 1942.

K. Waste Water Treatment System for the Primary and Bar Mills: The waste water treatment system for the primary and 22" bar mill at the Duquesne Works, located just south of the heat treatment building, treats all contact water used in the respective mills and recycles it back into their systems. The following integrates the structures and equipment making up the system with a description of their function.

1. Clarifier and Sludge Pumps: The 100' diameter x 13' high Dorr-Oliver clarifier is located just south of the system's cooling water tower and is made out of steel construction. It has a 15' diameter centerwell, a 5 hp motor-powered rake and oil skimmer, and a 2'-6" wide x 3'-0" deep launderer which encircles its circumference. Two 7.5 hp motored-powered Wemco-Envirotech sludge pumps with a rating of 100 gpm each are located in a corrugated metal lean-to that is adjacent to the southern side of the clarifier.

Waste water from the primary and 22" bar mill lift stations entered the centerwell at the bottom of the clarifier and rose slowly, thus allowing about 50 percent of its suspended solids to settle at its bottom. In order to enhance the coagulation of suspended solids both alum and polymers were added to the waste water as it entered the centerwell. The clarifier's skimmer removed floating oil from the waste water and stored it in a 2,200-gallon scum tank adjacent to the clarifier. The partially cleaned waste water subsequently overflowed into the clarifier's launderer and was directed by gravity into a filter feed tank. The rake mechanism directed the settled sludge to the sludge pumps where it was pumped to the thickener.

Installation date: 1981.

2. Filter Feed Tank, Process Pump Building, Process Building, Pressure Filters, and Spent Backwash Tank: Located adjacent to the clarifier on its southeastern side, the filter feed tank is an 25' diameter x 12' high, circular steel tank with a sloped bottom. The partially cleaned waste water from the clarifier passes through the filter feed tank into the suction, which is located in a small well at the bottom of the tank, for three filter feed pumps. The 5200 gpm capacity Wilson-Snyder filter feed pumps are located in the process pump building.

The one story, 18'-6" wide x 58'-6" long concrete block process pump building is laid out on a north-south axis and located just east of the filter feed tanks. Built from a concrete foundation by the American Bridge Company, the building has a flat roof. The filter feed pumps, which are located in the northern end of the building, deliver the partially cleaned waste water to one of six pressure filters located in the process building.

The two story, 46' wide x 177' long, corrugated metal, process building is located just east of the process pump building. Built on a concrete foundation by the American Bridge Company, the steel-framed building has two ventilation hoods protruding out of its roof. The building's gable roof is supported by Fink trusses. The 12' diameter x 25' high pressure filters are located in two rows of three filters each in the mid-western end of the building. They protrude through the second floor of the building and consist of three layers of filtration media composed (from top to bottom) of anthracite coal, sand, and gravel. The partially cleaned waste water was pumped to the top of the filters where it flowed downward before being directed to the cooling tower. The filters were periodically cleaned by backwashing or reversing the flow of the water through them and by blowing air from two blowers located in the first floor of the process building into the filters at the same time in order to enhance the scouring action. Spent backwash water was subsequently directed by gravity to the spent backwash tank.

The spent backwash tank is located next to, and just south of the filter feed tank. Constructed by the Chicago Bridge and Iron Company, the 25' diameter x 18' high, open-top circular steel tank is equipped with a turbine mixer in order to keep the solids within the backwash water suspended. Two 150 gpm capacity Wilson-Snyder centrifugal spent backwash water pumps, located in the southern end of the process pump house, pumped the backwash to the thickener.
Installation date: 1981

3. Cooling Tower, Cold Well, and Cold Well Pumps: The approximately 30' long x 10' wide x 15' high Bac-Pritchard cooling tower is laid out on an east-west axis and located just north of the clarifier. It is a mechanical draft, wood (Douglas fir) filled tower with three individual cells. The tower works by accepting the normal discharge from the pressure filters through distribution nozzles at the top of each cell. The water flows downward through the fill material to a 300,000 gallon concrete cold well basin located beneath the tower. Draft air was drawn through the tower by fans located at the top of each cell. The cooling tower reduced the water temperature from 105

degrees F to 85 degrees F.

The cold well basin is located at the eastern end of the cooling tower. Four Worthington 150 hp motor-powered process water pumps, each with a capacity of 3,000 gpm are located on a platform above the cold well. These pumps are used to return process water to the primary and bar mills.
Installation date: 1981.

4. Thickener: The 25' diameter x 15'-9" high, 50,000 gallon thickener was constructed by the Chicago Bridge and Iron Company. It is located just south of the Process Pump Building. Solids from the clarifier and the spent backwash tank were concentrated in the gravity thickener by means of a mechanically operated rake arm which was raised and lowered in the thickener tank. The flows were introduced into the thickener tank through a trough which discharged into the center feed well. Sludge was received into the thickener at concentrations ranging from 5 percent to 20 percent solids by weight. The sludge was concentrated to approximately 30 percent solids by weight in the thickener. The thickener also contained a polymer feed system to add polymer to the thickener in order to enhance settling, if required. The overflow from the thickener flowed by gravity to the clarifier. Thickened sludge was pumped by one of two constant speed horizontal, centrifugal thickener underflow sludge pumps, located beneath the thickener, to the vacuum filters.
Installation date: 1981.

5. Vacuum Filters and Vacuum Pumps: Two Dorr-Oliver, 12' diameter x 12' long cloth covered rotary vacuum drum filter assemblies are laid out alongside each other on the second floor of the Process Building at its southern end. These are serviced by two Dorr-Oliver, Nash Type CL vacuum pumps which are located just to the west on the second floor. The vacuum filters, operating in the same way as those used at the blast furnace and basic oxygen plants, dewatered the thickened sludge. After vacuum filtration, the filtered sludge cake was discharged through two sludge cake chutes (one located at each vacuum filter) into the sludge storage area. Periodically, the dewatered sludge is removed from this area by a front-end loader and trucked to a final disposal site.
Installation date: 1981.

HISTORY

The 22" Bar Mill was originally constructed in 1906. Over the years a number of changes and additions have been made to both the physical complex and the equipment within the complex. For example, the original steam-engines which drove the 28" and

22" mills were replaced with electric motors in the mid 1930s. Additions made during the early 1940s include the Pre-Heating Furnace Building and the Continuous Pre-Heat Furnace, the 22" Bar Stocking and Finishing Building and equipment, the 22" Bar Mill Shipping Building's No. 1, 2, and 3, and the 22" Bar Mill Shipping Office.[1]

The waste water treatment facilities for the Primary and 22" Bar Mill's were added in 1981.[2]

ENDNOTES:

1. Duquesne Works: Plant Description Book.

2. Metcalf & Eddy Inc., Operation Manual: Rolling Mills Division Primary and Bar Mills Waste water Recycle Facilities.

POWER GENERATION AND TRANSMISSION

<u>Historic Name</u>: U.S.S. Corporation, Duquesne Works, Power Plant
<u>Present Name</u>: U.S.X. Corporation, Duquesne Works, Power Plant
<u>Location</u>: Upper Works
<u>Construction</u>: 1924, 1957, 1962
<u>Documentation</u>: Photographs of the Power Plant can be found in HAER No. PA-115-E.

DESCRIPTION

I. <u>River Intake Building</u>: Laid-out on a north-south axis, the one story, 46' long x 24' wide River Intake Building is located on the edge of the Monongahela River's shoreline, approximately 35' north of the Car Repair Shop (Old Ladle House). Constructed on a concrete foundation by the American Bridge Company, the building's brick exterior encases a steel frame. The building's slanted roof is supported by Fink trusses. Laid out on a straight line on top of a small balcony off of the inside eastern wall of the building are three small motor-driven winch drum assemblies which were used to raise and lower the three sluice gates that admitted river water into the works' water system. Located near the eastern wall of the building on the first floor and also laid out on a straight line running north and south are three motor-driven assemblies which powered a chain belt manufactured by the Rex Chain Belt Company. The assemblies were used to rotate screens which filtered out debris from river water that was being introduced to the work's water system. All equipment was serviced by one of two manually operated Harrington-Peerless 2-ton overhead cranes which were located near the eastern or western wall of the building.

Original construction date: 1896, modified: 1924.

II. <u>Main River Water Pump House</u>: The one story high Main River Pump House is located 34' due north of the Car Repair Shop. It consists of an older, main section, 132' long x 45' wide that was constructed on a concrete foundation by the Keystone Bridge Company. A 43' long x 30' wide annex, and a 35' long x 45' wide corrugated metal annex have been added to its respective northern and southern ends. Laid out on a north-south axis, the building's steel frame is encased by brick walls. Riveted Fink trusses support its gabled roof. Tall segmented archway windows rim the eastern and western walls of the building. The building consists of two floors (first floor and basement), both of which are functional. The first floor is composed of a walkway which surrounds a large opening cut into the middle of the floor that provides access to the basement or operating floor for a 5-ton overhead travelling crane. A Nash Hy-tor vacuum pump, located at the midpoint of the first floor near the inside western wall, drew air from the outside by means of a hole cut into the wall and pushed it downstairs into the basement, thereby ventilating the facility.

The basement houses eight large centrifugal pumps which provided service and process water to the different plants within the works. In the original section of the building there are four Worthington, 800 hp steam turbine engines which each drive a Wilson-Snyder Pump rated at 15,650 gpm. Equally spaced, each steam turbine/pump arrangement is laid out on an east-west axis. The northern annex of the building contains two electric motor/centrifugal pump arrangements, each laid out on a east-west axis. The northern most arrangement consists of a 800 hp Western Electric induction motor driving a 14,000 gpm centrifugal pump manufactured by the DeLaval Steam Turbine Company. The other arrangement consists of an EM Heavy-Duty Squirrel Cage induction motor driving a 14,000 gpm Wilson-Snyder Pump. The southern annex contains two equally spaced 880 hp Elliot Steam Turbine/26,000 gpm Wilson-Snyder pump arrangements which are laid out on a north-south axis.

Construction dates: original pump house, 1896; northern annex, ca. 1910; southern annex, ca. 1925.

III. Water Treatment Filter Building and Reaction Tanks: Laid out on a northwest-southeast axis, the Water Treatment Filter Building and Reaction Tanks are located approximately 150' north of the blast furnace ore yard near the western boundary of the works. The structures and equipment--consisting primarily of four 43' diameter, 487,700 gallon reaction tanks and a two story, 66'-6 1/2" long x 57'-6 1/2" wide brick building--within this area were used to soften and remove excess particulate from water to be used in the works' boiler or steam production system. Water was delivered from the main river water pump house to one of the reaction tanks where it was treated with water softening chemicals (i.e. lime, soda ash, sodium aluminate, and polymer) before being pumped over to the filter building where it was passed through gravity sand filters in order to remove remaining particulate. Upon passing through the sand filters, the water settled into a reservoir where it was decanted before being pumped to the boiler feed water system located in Blow Engine House No. 2.

Located between the reaction tanks, which are laid out in pairs forming two rows, is an approximately 30' square x 9' high corrugated metal shed. The shed provides a covering for the 30 hp motor-drive assemblies that control the mixer impellers, manufactured by the Lightning Mixing Equipment Company, located in each tank.

The Water Treatment Filter Building was built on a concrete foundation by the American Bridge Company. The process steps by which the water was treated follows successively from the second floor of the building down to its basement.

Four approximately 6' diameter x 4' high chemical mixing tanks are laid out linearly and located near the northwestern wall on the second floor of the water treatment filter building. Running directly above the mixing tanks is a 5 hp motor/shaft assembly which drives the impellers in each container. A 7.5 hp Louis Allis motor/Labour Company pump arrangement, located at the northwestern corner of the floor, delivers chemicals (lime, soda ash, etc.) that were mixed in the tanks through 3" diameter pipes to the reaction tanks. The operators office, containing the main control panel for the system, is located in the southwest corner of the floor.

Located on the first floor of the building are eight approximately 15' wide x 20' long gravity sand filters, laid out in groups of four along the northeastern and southwestern walls. A small 20 hp Westinghouse Induction motor/100 gpm Weinman pump arrangement is located in the northwest corner of the first floor. It was used for flushing and draining the chemical mixing tanks.

The basement of the building consists of a 66'-6" long x 56'-6" wide reservoir located directly below the gravity sand filters and a 16'-8" long x 34'-8" wide pump pit/weir which was built off of its southeastern end. A small decanting pump transferred the water over the weir into the pump pit where it was delivered by larger pumps to the boiler feedwater system.
Construction date: 1924.

IV. Boiler Feedwater System: The boiler feedwater system is located in the northeastern corner of Blow Engine House Number Two. The equipment making up the boiler feedwater system is located on two floors. The upper level contains four approximately 10' diameter x 18' long Cochrane deaeration heaters, laid out across the floor on an east-west axis. Deaeration is the process by which dissolved gasses in the boiler feedwater are removed. Dissolved gasses, particularly oxygen, react rapidly when coming into contact with iron surfaces, thereby depleting the iron. Because boiler tubes are made out of iron, deaeration of the boiler feedwater is essential. The deaeration process involves two steps: ebullition and diffusion. Ebullition takes place immediately when the boiler feedwater is sprayed into the heater. Spraying reduces the solubility of the dissolved gases to such an extent that 90 percent of the gases are carried away by the vented steam from the heater. In the second step, the feedwater cascades down through diffusion trays located inside of the heater, countercurrent to steam, which is passing up through the trays. The phenomena of continually diluting the dissolved gasses in the feedwater with steam reduces the oxygen content to 30-50 parts per billion. After deaeration is complete, the feedwater is drawn off by the boiler feedwater pumps and delivered to the Central Boiler House.

The lower level contains ten boiler feedwater motor and steam turbine/pump arrangements, laid out in four rows across the floor on an east-west axis. The steam turbines were manufactured by either the Elliot, Worthington, or DeLaval Steam Turbine companies, while the electrical motors were manufactured by either the Westinghouse, General Electric, or U.S. Electrical companies. The average horsepower rating for the turbines and motors is 325. The pumps were manufactured by either the Pacific, Wilson-Snyder, or DeLaval companies. The average gallons per minute rating on the pumps is 1000.

Installation of system: 1924.

V. <u>Central Boiler House and Coal Bunker Building</u>: The six story, 228' long x 92' wide Central Boiler House is laid out on a north-south axis. Constructed on a concrete foundation by the American Bridge Company, the building consists of riveted steel-framework with brick walls at its first floor and steel plate walls for its remaining height. Its monitor roof is supported by a riveted Pratt truss.

The first floor of the building consists of several offices and a series of spare parts storage bins. Twelve boilers are laid out in two rows on the second or operating floor of the building. The boilers are presently equipped to operate on natural gas, clean blast furnace gas, coke-oven gas, mixed gas, or fuel oil No. 6 (depending on the availability and cost of each particular fuel at any given time). The third floor of the building houses the steam drums and combustion air fans for each boiler. The boilers extend to the fourth floor of the building where there is also a large stack protruding out of the roof of the building at each boiler, and two large pipes leading into the top of each boiler. Located on the fifth floor of the boiler house is a large steam-turbine/fan assembly for each boiler. Used to provide forced draft air to the boilers, each assembly consists of a Sturtevant steam-turbine rated at 180 hp, and a Clarage fan. An induced draft steam-turbine/fan per boiler is located on the building's sixth floor. The fan is used to circulate waste gases from the combustion chamber through the boiler before being removed from the boiler stack. Each assembly consists of a 550 hp Sturtevant steam-turbine and a Clarage fan.

The eleven story, 88' long x 45' wide Coal Bunker Building is adjacent to the northern wall of the boiler house. Laid out on a north-south axis, the riveted, steel-framed and corrugated metal clad building was constructed on a concrete foundation by the American Bridge Company. Its gable roof is supported by Fink trusses. The building was used to house machinery and equipment which could provide crushed coal to the boilers in the Central Boiler House. Located on the 11th floor of the building is a counterweight winch drum and its casing. Four counterweight winch drums and their casings, which are connected by a 1" diameter rope to the counterweight winch drum on the 11th floor, are located on the 10th floor. Two skip tracks upon which the skip cars delivered coal to the boiler system ends at the 9th floor of the building. Leading from the top of the skip tracks to the coal crusher on the 8th floor are two chutes. The crusher itself was manufactured by the DeLaval Company. The crushed coal was delivered by means of a chute to the 7th floor of the building where it passes through a 10' square screen. The screen divides the useable coal from the slack, delivering the useable coal, by means of a pair of chutes, to one of two 15' square bins on the 6th floor, while the slack was directed to the slack coal bin on the 6th floor. The useable coal bins act as reservoirs from which the coal is delivered by means of a chute to a conveyor located near the western wall of the building on the 3rd floor where one of two tripper cars transfer the coal into a series of bins suspended from the floor, thereby providing part of the ceiling of the 2nd floor. The 2nd floor of the building contains a recording panel near the eastern wall at its southern end. The panel measures natural and clean blast furnace gas pressure and flow. A doorway on the east wall of the building, and near its northern wall, leads to an approximately 20' long x 10' wide x 25' high motor room for the coal skip hoists. There are two large D.C. motor/gear drive/winch drum assemblies located in the room. The stock house for the delivery of coal to the skip hoist system used to be located below grade level in the basement of the building. It was demolished in the early 1970s after the last of the six original coal fired boilers were converted to gas fuel.

Construction date: 1924.

VII. Electric Power House No. 1 (Currently Armature Weld Shop): The one story, 295' long x 50' wide former Electric Power House No. 1 is laid out on a north-south axis, just north of the Main River Pump House. Constructed on a concrete foundation by the Keystone Bridge Company, the building's brick exterior encases its steel framework. A corrugated metal gable roof is supported by riveted Fink trusses. Large segmented arch windows rim the structure's southern, eastern, and western walls. A 10-ton E.O.T. crane spans the width and runs the length of the building.

Electric Power House No. 1 once contained the mill's original steam-driven reciprocating electrical generator. It was converted to a shop for the repair of small motors and contained a number of storage bins for motor parts at the time of the HAER inventory.

Construction date: 1896.

VIII. Electric Power House No. 2: Laid out on a north-south axis, the two story, 264' long x 90' wide Electric Power House No. 2 is located 25' east of Blowing Engine House No. 3. Constructed on a concrete foundation with a concrete floor by the American Bridge Company, the building's brick exterior encases a steel framework. A corrugated metal gable roof is supported by riveted Pratt trusses. Two rows of large segmented arch windows exist on its eastern and western walls. A 30-ton E.O.T. crane spans the width and runs the length of the building. At the time of the HAER inventory the building was completely gutted.

An approximately 50' square, two story brick office building with a flat roof is built off of the northern wall of the building. The offices in this building contain equipment and instrument panels that were used to monitor the power usage of all of U.S. Steel's Monongahela Valley steel mills.

Original construction date: 1907.

Construction date of brick office addition: ca. 1965.

IX. Low Purity Linde Oxygen Making System: The extant equipment making up the low purity oxygen making system (95 percent pure oxygen) is located in and around Blow Engine House No. 1. Located inside of the blow engine house at its eastern end are two reversing heat exchangers and a nitrogen regenerator connected together in triangular fashion by 7' diameter pipes. The 20' diameter heat exchangers are approximately 50' high while the nitrogen regenerator, also 20' in diameter, is about 75' high. Located near the triangular arrangement and connected to it by an approximately 2' diameter pipe is a 7' diameter Trane heater that is about 80' high. Just north of the above arrangement, near the building wall, is an expansion turbine driven by a 600 hp induction motor. Both the expansion turbine and the heat exchanger/regenerator are connected by pipe to a twin fractionating tower located just outside of the northern wall of the building. These approximately 20' diameter towers are about 75' high. Leading from the fractionating towers to a set of three approximately 4' diameter x 40' long liquid oxygen holding tanks is a manifold of pumps and pipes. The holding tanks are laid out horizontally on top of an approximately 20' long x 40' wide x 20' high steel framed platform.

Construction date: 1957.

X. High Purity Linde Oxygen Making System (MR-1000 Plant): The equipment making-up the high purity oxygen making system (99.5 percent pure oxygen) is located in Blow Engine House No. 1 and just east of the Central Boiler House between Blow Engine House No. 1 and Blow Engine House No. 2. Located inside of Blow Engine House No. 1 at its western end is a large two stage Allis-Chamlers compressor (1st stage axial, 2nd stage centrifugal) which is driven by a Worthington steam turbine. The first stage of the air compressor is rated at 125,000 cfm, while the second stage is rated at 44,400 cfm. The steam turbine is rated at 10,250 hp. Air entered the first stage of the compressor after passing through a small filter house located in the northwest corner of the building. Compressed air left the second stage of the compressor through an approximately 2' diameter pipe that extends along the eastern wall of the Central Boiler House before turning into an approximately 10' diameter x 50' long surge tank located on the roof of a two story cinder block building, just east of the various towers used for separating out the constituent elements of the compressed air. After passing through the surge tank, which dampens pressure fluctuations in the system, the air was led to the two reversing heat exchangers and three nitrogen regenerators located alongside each of the MR-1000 plant's two fractionating towers. The fractionating towers are each composed of an upper and lower column separated by a condenser.

The approximately 20' diameter x 50' high reversing heat exchangers and nitrogen regenerators were used to cool down the compressed air to temperatures of -300° F. This was accomplished in the regenerators by running the incoming air against outgoing waste nitrogen which deposited moisture, carbon dioxide, and most of the hydrocarbons as solids in the regenerator packing. That portion of the compressed air which was directed to the reversing heat exchangers is cooled against the outgoing oxygen and high purity nitrogen products respectively. Both the reversing heat exchangers and the regenerators have side bleed take-off points which passed about 15 percent of the air through one of two 5' diameter x 15' high side bleed gel traps located near each fractionating tower for the removal of any remaining carbon dioxide and hydrocarbons. The air that left the cold end of the reversing heat exchangers and the regenerators (about 85 percent of the total) passed through one of two 5' diameter x 15' high cold end gel traps located near each fractionating tower for the same purpose.

Most of the air which left the side bleed gel traps flowed to one of two expansion turbines (one at each fractionating tower) where the temperature is lowered by expansion to near the liquescent point. From the turbines the air was fed to the upper level of each fractionating column at tray forty-five where it provided the refrigeration for the cycle. The remainder of the air from the side bleed gel traps was fed to the lower column of its respective fractionating tower (below tray 1) where it was rectified or distilled in order to obtain high purity liquid nitrogen for reflux to the upper column.

The air vapor from the cold end gel traps entered the bottom of the lower column, which was composed of sixty-three trays, and rose through twenty-three trays where it was rectified into nitrogen vapor. The nitrogen vapor then passed through the lines connecting the lower column with the high pressure side of the main condenser. It flowed into the condenser where it was liquefied by the refrigeration supplied by boiling liquid oxygen on the other side of the condenser. A portion of this nitrogen liquid was then fed to the lower column at tray twenty-three while the remainder flowed through the shelf nitrogen subcooler where it was cooled and subsequently fed to tray sixty-three. Liquid is also taken from the kettle of the lower column and fed into the upper column at tray fifty-one.

The upper column contains sixty-three trays similar to those in the lower column. Liquid flows down across the trays to the oxygen side of the condenser where it was vaporized. This vapor, rising from the condenser to the upper column, flowed up through the sieve type trays bubbling through the liquid that was flowing down, causing a nearly complete separation of the air into 99.5 percent pure oxygen at the bottom and approximately 99 percent pure nitrogen vapor at the top of the upper column as waste nitrogen.

Waste nitrogen left the upper column in two streams. One stream flowed through the three-core section of the waste nitrogen heat exchanger where it was used to cool the liquid shelf nitrogen from the main condenser and liquefy some air which was fed to the lower column at tray three. The second stream of waste nitrogen left the upper column above tray sixty-three and flowed through the two-core section of the waste nitrogen heat exchanger where it was also used to cool the shelf liquid that was being fed to the upper column and to cool the side bleed air which was then fed to the lower column below tray one. After leaving the heat exchangers, the waste nitrogen flowed to the nitrogen regenerators and reversing heat exchangers where it gave up its refrigeration to the incoming air.

Product gaseous oxygen was taken from the upper column just under tray one and passed through the oxygen superheater where it was used to liquefy a portion of the cold end air. After leaving the superheater, the oxygen was fed to the reversing heat exchangers where it flowed through the nonreversing passes concurrent to the incoming air. Upon leaving the reversing heat exchangers the gaseous oxygen was compressed to approximately 250 psig by one of two baseload oxygen compressors which are inside of an approximately 100' square cinder block building located just north of the MR-1000 plant. After passing through the compressors, the oxygen was fed into the pipe line which fed it to the different production systems at Duquesne as well as U.S. Steel's other Monongahela Valley steel mills (i.e. National Works, Homestead Works, Irvin Works, and the Edgar Thomson Works). The oxygen which passed through the baseload compressor that was not delivered to the company's pipeline system was fed into one of two oxygen booster compressors (located in the same building) where it was compressed to 425 psig before it was transferred to a storage tank (no longer extant) to be used as a back-up supply.

Also extant from the MR-1000 plant is an argon storage tower and a partially dismantled Dimage, two stage centrifugal compressor. The remains of the compressor sits on an approximately 20' square x 20' high steel-framed, gable roof covered, concrete platform which is located just north of the MR-1000 plant.

Construction dates: 1962 and ca. 1975.

HISTORY

The power plant at the Duquesne Works has consisted, over the years, of a steam production system, an electrical generating system, and an oxygen making system. The mill originally employed a decentralized steam production system whereby river water was pumped through the main pump house to a series of boilers which were located at each stage of the production process (i.e. blast furnace plant, bessemer converting house, open hearth furnace shop, primary rolling mills, and bar rolling mills). The potential for bottlenecks in the production process because of boiler failure at any one stage of production, however, led company officials to centralize the system by constructing a Central Boiler House in 1924. It originally contained six gas-fired and six coal-fired boilers. In addition, a cold water treatment facility consisting of four 487,000 gallon reaction tanks and a Water Treatment Filter Building were constructed while deaeration heaters and a boiler feedwater system were installed in Blow Engine House Number 2. The original coal-fired boilers were gradually converted to gas between the mid-1950s and the 1970s because of the enforcement of strict air quality legislation in Allegheny County.[1]

The electrical generating plant at the Duquesne Works dates back to 1897 when a steam-driven reciprocating electrical generator was installed in conjunction with the mill's new blast furnace plant. In 1907, the addition of two new blast furnaces also included the construction of an Electrical Power House which contained two blast furnace gas-fired reciprocating electrical generators. A third, steam-driven centrifugal electrical generator was installed in the building during the 1950s. By the time of the HAER survey, all of the electrical generators in the mill had been dismantled.[2]

An on site oxygen production system, the steel industry's first, was installed in Blow Engine House No. 1 at the Duquesne Works in 1957 when the Linde Division of the Union Carbide Corporation constructed a low purity oxygen plant (95 percent pure oxygen). This plant was utilized to provide oxygen enrichment to the mill's two ferromanganese blast furnaces and to its electric furnaces and open hearth furnaces. In 1962, Linde partially dismantled the old plant to make way for a new high purity system (99.5 percent pure oxygen) capable of producing 1365 tons of oxygen per day. Necessitated by the construction of a basic oxygen steelmaking plant at the Duquesne Works, the high purity system also serviced the oxygen needs of all of U.S. Steel's Monongahela Valley steel mills. In the mid-1970s the original air compressor associated with the high purity plant was replaced by a steam-turbine driven air compressor which was installed in Blow Engine House No. 1.[3]

ENDNOTES:

1.United States Steel Corporation, "Duquesne Works: Plant Description Book," (Duquesne: 1925).

2."Electricity at the Duquesne Furnaces," Iron Trade Review 30 (March 11, 1897): 16; A. N. Diehl, "Data Pertaining to Gas Cleaning at the Blast Furnaces," Transactions of the Institute of Mining Engineers 50 (1915): 3-46.

3."Oxygen Boosts Furnace Output," The Iron Age 179 (June 13, 1957): 91; Harold E. McGannon, ed., The Making , Shaping, and Treating of Steel, Eighth Edition, (Pittsburgh: 1964): 266-68; Linde Company, "Operating and Maintenance Instructions for XB-365A (MR-1000) Plant at United States Steel Corporation, Duquesne, Pennsylvania," (Tonawanda, NY: 1963): 1-27.

AUXILIARY BUILDINGS AND SHOPS

<u>Historic Name</u>: U.S.S. Corporation, Duquesne Works, Auxiliary Buildings and Shops
<u>Present Name</u>: U.S.X. Corporation, Duquesne Works, Auxiliary Buildings and Shops
<u>Location</u>: Duquesne Works
<u>Construction</u>: varied
<u>Documentation</u>: Photographs of the Auxiliary Buildings and Shops located in HAER No. PA-115-F.

DESCRIPTIONS AND HISTORIES

I. <u>Locomotive Repair Shop</u>: Laid out on a north-south axis, the two story, 119'-6" long x 72'-1" wide Locomotive Repair Shop is located 40' east of the 21-inch Mill Inspection Building at the northern end of the upper works. Constructed on a concrete foundation with a concrete floor by the American Bridge Company, the steel-framed building is covered with corrugated metal. Its gable roof and monitor is supported by combination wooden Pratt trusses and steel tie rods. Located inside of the building are four repair pits, each approximately 100' long x 4' wide x 7' deep, which run parallel to each other. They were used to provide repair access to the underside of company owned locomotives. Access to the two repair pits on the eastern side of the building is provided by a pair of standard gage railroad tracks which run through an opening in the northern wall of the building. Access to the repair pits on the western side of the building is provided by a pair of standard gage railroad tracks which run through an opening in the southern wall of the building. The building also contains a tool room and a small office, both of which are located in its northwest corner. Located along the building's eastern wall is a turret lathe and a U.S. Electrical Co. grinder. A smaller turret lathe is located along the western wall of the building and a Hammond Machinery grinder is located along the northern wall.
Construction date: ca. 1900.

II. <u>Boiler Shop</u>: Located just east of the Locomotive Repair Shop, the two story, 114' long x 70' wide Boiler Shop is laid out on a north-south axis. The steel-framed, corrugated metal building was constructed on a concrete foundation by the American Bridge Company. Its gable roof and monitor are supported by Pratt trusses. A 5-ton E.O.T. crane runs the length of the building. Once utilized for the fabrication of steel plate forms, the inside of the Boiler Shop was completely gutted at the time of the HAER inventory.
Construction date: ca. 1910.

III. Machine Shop: Laid out on a north-south axis just east of the Boiler Shop, the two story, 220' long x 122' wide Machine Shop is the oldest structure on the Duquesne Works site. Constructed on a concrete foundation by the Keystone Bridge Company, the steel-framed building has a brick exterior and a concrete floor. Its gable roof and monitor are supported by Pratt trusses. Segmented arched windows run along the upper part of the building's eastern and western walls. The inside of the building is divided into three bays which run its length. The eastern bay of the building contains tool storage bins that sandwich a small office at the center of the bay. The building's center bay is serviced by 30/10-ton E.O.T. crane. Once used to machine parts for much of the mill's production equipment, the Machine Shop was, at the time of the HAER inventory, completely gutted of all machinery.

Built off of the northern wall of the Machine Shop are two small, one story tall, brick lean-tos. One lean-to was used as an office while the other was used as a locker room.

Construction date: 1887.

IV. Pattern Storage Building: The six story, 116' long x 56' wide Pattern Storage Building is laid out on a north-south axis approximately 100' west of the 21-Inch Mill Inspection Building at the northern end of the upper works. Constructed by the American Bridge Company on a concrete foundation, the building's brick exterior encases its steel framework. Dormer windows rim the third floor of the building, while segmented arched windows exist on each of its other five floors only on its eastern wall. The building's corrugated metal gable roof is supported by Fink trusses. A covered stairway leading to the second floor of the building is located at its northern outside wall. Attached to the southern outside wall of the building is an elevator which was used to transport large patterns to and from its storage floors.

The layout of the building's sixth floor consists of a single bay in which large patterns are stored. The layout of the fifth and fourth floors includes two rows of large tiled columns which divide the floors into four equal bays. Both floors are used for the storage of patterns. The third floor of the building consists of a center aisle which is flanked by a series of wood panelled maintenance division offices. The arrangement of the third floor is the result of a reconstruction which took place in the early 1970s. The northern end of the second floor of the building was utilized for the storage of gas rescue equipment. Just south of this storage space is a center aisle flanked by a oxygen bottle repair office on its eastern side and a locker room on the western side. The southern end of the floor (about half the floor space) was utilized as a pattern storage area. The northern third of the first floor is made up of a garage for the storage of a fire truck and ambulance. The rest of the floor contains a locker room, wash room, and offices.

Construction date: 1907.

Remodelling of third floor: ca. 1970.

V. Carpenter Shop: Laid out on a north-south axis, the two story, 84' long x 44' wide Carpenter Shop is located 20' west of the Pattern Storage Building at the northern end of the upper works. The steel-framed brick building was constructed on a concrete foundation by the American Bridge Company. The building's gable roof is supported by wooden Pratt trusses. Large segmented arched windows rim the four walls of the building at both its first and second floors. There is an approximately 10' wide x 12' high arched doorway located on the western wall of the building which leads into the first floor.

The ground floor of the Carpenter Shop has been gutted of all its equipment. At present, the floor contains storage bins which contains mill artifacts that are being saved for the Historical Society of Western Pennsylvania. All of the equipment which existed on the second floor of the building has also been removed. The floor presently contains a series of book shelves which are used to store technical journals, books, and mill records that were found in various locations in the mill. They too are being saved for the Historical Society.

Built off of the northern wall of the building at its northwest corner is a one story, 23' long x 15' wide steel-framed brick office. The office's gable roof is supported by Fink trusses. Arched windows rim the walls of the building extension. Located inside of the office are various kinds of employee records.

A lean-to is built between the Pattern Storage Building and the western wall of the Carpenter Shop. Its roof is made of corrugated metal, while its northern wall is made of wood clapboards. The southern end of the lean-to is open. A walkway between the Pattern Storage Building and the second floor of the Carpenter Shop is adjacent to the southern end of the lean-to.

Adjacent to the lean-to on its northern side is an approximately 30' long x 10' wide x 8' high corrugated metal shed, which was used for storing paint.

Construction date: ca. 1910.

VI. Hospital and Main Guard House Buildings: Laid out on a east-west axis, the one story, 55' long x 33' wide Hospital Building is located at the northwest corner of the upper works, about 80' north of the Carpenter Shop. The steel-framed brick building with a hipped slate roof was constructed on a concrete foundation by the American Bridge Company. Glass block windows rim the four walls of the building. The building contains a large hospital bay and a small X-Ray room. Built off of the northern wall of the Hospital is a 25' long x 10' wide x 10' high Guard House Building with a flat roof. A stairway in the Guard House leads to the basement of the hospital which contains rest rooms and a locker room. Construction date: ca. 1910.

VII. <u>Blacksmith Shop</u>: The two story, 100' long x 65' wide Blacksmith Shop is laid out on an east-west axis about 25' south of the Boiler Shop. Constructed on a concrete foundation by the American Bridge Company, the steel-framed corrugated metal building has a gable roof which is supported by Fink trusses. At the time of the HAER inventory the Blacksmith Shop was completely gutted.
Construction date: ca. 1910.

VIII. <u>Air Compressor Building</u>: Laid out on a north-south axis, the two story, 42' long x 35' wide Air Compressor Building is located about 55' south of the 21-Inch Mill Inspection Building. Built on a concrete foundation by the American Bridge Company, the building's brick walls encase steel frame. Its gable roof is supported by Fink trusses. Three ventilation hoods protrude up through its roof. Dormer windows rim its northern, southern, and western walls. An approximately 10' wide x 12' high entrance way along its western wall is flanked by two small brick lean-tos which housed offices. Located inside of the Air Compressor Building are four concrete air compressor foundations. The compressors themselves have been dismantled.
Construction date: ca. 1910.

IX. <u>Air Receiver Building</u>: The two story, 63' long x 47' wide Air Receiver Building is laid out on a north-south axis, practically adjacent to the Air Compressor Building. Constructed on a concrete foundation by the American Bridge Company, the western and southern walls of the steel-framed building are constructed of brick, while its northern and eastern walls are corrugated metal. About half of the building's western wall is shared with the eastern wall of the Air Compressor Building. Its gable roof is supported by Pratt trusses. At the time of the HAER survey the inside of the building was completely gutted.
Construction date: ca. 1910.

X. <u>General Storehouse</u>: Laid out on a northwest-southeast axis, the two story, 129' long x 54' wide General Storehouse is located about 50' south of the Water Treatment Filter Building.

Constructed on a concrete foundation by the American Bridge Company, the steel-framed building has a brick exterior. Its corrugated metal roof is supported by Pratt trusses. Segmented arch windows rim the building's four walls on both floors. The first floor of the building houses a counter space at its northwestern end which was used to dispense supplies such as metatarsal shoes and hard hats to the workforce. The rest of the first floor is composed of storage bins. The second floor houses offices.

Built off of the southeastern wall of the General Storehouse is a small, one story brick lean-to. It was used for the storage of brass scrap.

A one story, 19' long x 25' wide, general storeroom with a brick exterior is built off of the lean-to. Constructed from a concrete foundation, the building's gable roof is supported by Fink trusses.

Constructed off of the southwestern wall of the General Storehouse is a two story, corrugated metal lean-to which was used as a delivery unloading dock.
Construction date: ca. 1910.

XI. Oil House: Laid out on a northwest-southeast axis, the one story, 34' long x 27' wide Oil House is located about 5' northwest of the General Storehouse. Constructed from a concrete foundation by the American Bridge Company, the steel-framed building has a brick exterior with corbelling under the eaves of its corrugated metal gable roof. The gable roof is supported by Fink trusses. Two ventilation hoods protrude through the roof's peak. Segmented arch windows exist on three of the building's four walls. The inside of the building consists of a storage area for oil drums and a small office in its northeast corner.
Construction date: ca. 1910.

XII. Gas Cylinder Storage Building: The one story, 68' long x 18' wide Gas Cylinder Storage Building is laid out on a northwest-southeast axis near the 487,000 gallon Water Treatment Storage Tanks. Built from a concrete foundation by the American Bridge Company, the steel-framed building has a brick exterior. Its corrugated metal gable roof is supported by Fink trusses. Four ventilation hoods protrude from the peak of the roof. A 68' long x 6' wide loading platform is built off of the building's southwestern wall. The inside of the building was used as a storage space for acetylene gas bottles.
Construction date: ca. 1910.

XIII. General Services and Transportation Office: Laid out on a northeast-southwest axis, the one story, 47' long x 35' wide General Services and Transportation office is located 40' southwest of the General Storehouse. Constructed on a concrete foundation by the American Bridge Company, the steel-framed building has a brick exterior and a hipped slate roof. Rectangular windows are located on three of the building's four walls. A locker room exists in the cellar of the building. The main floor contains six offices.
Construction date: ca. 1910.

XIV. Millwrights Office Building: Laid out on a north-south axis, the one story, 25' long x 19' wide Millwrights Office Building is located at the northern end of the blast furnace ore yard. Built on a concrete foundation by the American Bridge Company, the steel-framed building has a brick exterior. Its corrugated metal gable roof is supported by Fink trusses. Corbelling exists just under the building's eaves. Segmented arch windows rim the four walls of the building. Its main floor contains four offices.
Construction date: ca. 1910.

XV. North Blast Furnace Sub-Station: Laid out on a north-south axis, the two story, 76' long x 32' wide North Blast Furnace Sub-Station is located 8' east of the Millwrights Office Building at the northern end of the blast furnace ore yard. Constructed from a concrete foundation by the American Bridge Company, the indoor electrical sub-station has a flat roof. Entrance into the building was prohibited at the time of the HAER inventory.
Construction date: ca. 1970.

XVI. Fuel and Instrument Building/Indoor Sub-Station: The two story, 66' long x 43' wide Fuel and Instrument Building is laid out on a east-west axis, approximately 100' east of the 487,000 gallon Water Treatment Reaction Tanks. Built on a concrete foundation by the American Bridge Company, the steel-framed building has a brick exterior with a flat roof. Corbelled brickwork exists along the cornice of the building. Rectangular windows rim both floors of the building on its northern, southern, and eastern walls. The building's first floor contains several instrument panels at its northern end and three offices at its southern end. The second floor contains a locker room.
Construction date: ca. 1925.

XVII. Brick Shed/Tool and Locker Room: Laid out on a east-west axis, the two story, 163' long x 52' wide Brick Shed is located 20' north of the Fuel and Instrument Building. Constructed on a concrete foundation by the American Bridge Company, the building's brick exterior encases a steel frame. Its gable roof and monitor are supported by Fink trusses. Square windows rim its northern, southern, and western walls at the second floor. The structure contains masonry offices on its first and second floor as well as storage space.

Construction date: ca. 1925.

XVIII. Plant Utilities Office Building: Laid out on a north-south axis, the two story, 96' long x 43' wide Plant Utilities Office Building is located 50' north of Electric Power House Number 1. Constructed on a concrete foundation by the American Bridge Company, the building's brick exterior encases a steel frame. Corbelled brickwork exists along the cornice of the structure. Its corrugated metal gable roof is supported by riveted Fink trusses. Rectangular windows rim its northern, eastern, and western walls. The first floor of the building contains several storage bins while the second floor consists of several offices.

Construction date: ca. 1920.

XIX. Paint Shop: Laid out on a north-south axis, the two story, 70' long x 25' wide Paint Shop is located 20' north of the Plant Utilities Office Building. Built on a concrete foundation by the American Bridge Company, the building's brick exterior encases a steel frame. Its corrugated metal gable roof is supported by riveted Fink trusses. Corbelled brickwork exists along the cornice of the building. Rectangular windows rim the structure's eastern, western, and southern walls. The first floor of the building consists of a washroom and a locker room. The paint shop itself was located on the second floor.

A two story, 11' square brick lean-to is located off of the northern wall of the building. Its inside was gutted at the time of the HAER inventory.

Construction date: ca. 1920.

XX. Main Office Building: Laid out on a north-south axis, the two story, approximately 125' long x 100' wide Main Office Building is located across Pennsylvania Route 837 from the upper works. Constructed on a concrete foundation, the steel-frame building has an ornate brick exterior and a slate hipped roof. Rectangular windows rim the four walls of the building at its basement, first, and second floors. An attic dormer juts out at the northern wall of the building.

By far the most elaborately designed of the buildings associated with the Duquesne Works site, the Main Office Building consisted of offices in its basement, first, and second floors for the Work's superintendent and his staff. Today the building is owned and operated by Allegheny County and has been renamed the Business Innovation Center.

Construction date: ca. 1910.